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Engineering News-Record

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August 11, 1927

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Bridges

Design of 3,500-ft. Suspension Bridge Across the Hudson River at New York

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Editor

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Singapore and Schenectady

ILLUSTRATIVE of the quickness of news of advances in engineering to reach distant cities, be acted upon there and the resulting experience reported back to the country of origin is the letter from Singapore, Straits Settlements printed on another page. The letter tells of the full-scale use of chlorination at the Singapore sewage-works prompted by an article on sewage chlorination studies at Schenectady, N. Y. Within about a year of the publication of our article, the letter mentioned, which summarizes some months of practical experience at Singapore, was received by us. Its publication has been slightly delayed so it might appear with Mr. Cohn's second article on the Schenectady studies, beginning on p. 227. Both the letter and the article promise to give impetus to the notable recent progress of sewage chlorination.

Gasoline Taxes Grow

GASOLINE taxes were created in two states and were increased in 22 states by the legislatures which have recently completed their sessions. The new taxes, in New Jersey and in Illinois, were 2c. a gallon. In four states, Alabama, Maryland, New Mexico, and Texas, the increase was 2c. a gallon. West Virginia and Wyoming added ½c., and 16 states added 1c. Three states now have a 5c. tax and ten states have a 4c. tax. No state has less than a 2c. tax. These figures are from the count of the secretary of the Association of State Highway Officials in his summary of highway legislation in 45 states. In only two states was any part of the gasoline tax increase designated for other use than road improvement. Indeed, in several instances its use for roads and its administration by state road departments were more specifically defined. Also, there was greater inclination shown to leave highway officials free in the matter of allotting the funds to construction or maintenance. Altogether the result of the year's legislation has been to strengthen the policy of gasoline taxation and the state highway departments in their control of the income from gasoline taxes.

Watch Demurrage

DEMURRAGE charges are dismissed by the average contractor as bills which he can only swear at and pay. He seldom professes to understand them. A total computed by the sliding scale of debits, credits and allowances which the railway rules provide, over-reaches his patience to break down and find where saving may be made. This is not good business. It is true that with even average management demurrage does not form a large item in the total cost of construction work but it is purely a net-profit-depleting expense. Some recompense remains where a production cost mounts up because it is creating some return but demurrage all comes out of the fund left for profit; it is dead expense. And there is no easy way of reducing the difficulty. The contractor who expects to eliminate demurrage must watch and work to do it. If he chooses straight demurrage he must not only keep an eye on his unloading time but he must formally and by rule claim his allowances for bad weather, interference and bunched deliveries. If he elects reciprocal demurrage he gains credits for quick unloading to balance debits for slow unloading but he loses virtually all allowances granted in straight demurrage. In either case he has a checking, bookkeeping and letter writing task on his hands which mounts into time and money. It is only natural then that contractors commonly decide to meet the difficulty by doing their best not to let unloaded cars accumulate and take their chances with other conditions which pile up demurrage bills. Often this is the cheapest method. But every contractor should know demurrage practice and rules and many contractors haven't this knowledge. Its possession would get them a credit and allowance which they now lose.

Maintenance Plant Management

REALIZATION of the importance of maintenance as an opportunity for skilled employment and as a market for road machinery is helped by the article in this issue on equipment management. Construction so far has played a more prominent part in the eyes of the equipment maker than has the more routine work of upkeep. Indeed, we may expect that for a long time, taking the country as a whole, it will continue the spectacular function of the road builder and the outstanding beacon to those who cater to his requirements. In actual count of equipment consumed and men employed in road improvement, however, maintenance holds no mean place. It is in emphasizing this fact that the article in this issue by an experienced maintenance engineer has one of its chief values. A business which requires an investment in machinery, tools, and buildings that approximates $4,000,000, and which gives employment to some 10,000 men, is not small even in these times of great public service organizations. And the road maintenance business in Pennsylvania, although it is larger than in most states, is only one of 48 similar businesses if we include alone the state-system road mileage in our computation. The sizes of even the smaller of these maintenance businesses, however, make the problem of plant management important. They call for an organization for testing, purchasing and upkeep comparable with that of a railway with its central and division shops, its purchasing department and its testing, inspection and accounting organizations.

To the Delaware for More Water

YEARS ago it became apparent that the Delaware River would ultimately be the main source of water supply for not only Philadelphia and New York but also for a score or more of municipalities between. Philadelphia already draws a large part of its supply from the Delaware and it is only a question of time before it will go higher up and take more. Trenton and some smaller New Jersey municipalities depend on the Delaware and Camden may yet do so. The trans-Hudson municipalities in Metropolitan New Jersey have already been advised more than once to reach out first for Delaware tributaries, then the main river. With a growing realization of all this, and of possible complications over interstate water problems, negotiations for a tri-state Delaware River compact were conducted from 1924 to 1927 and a second and modified treaty was formed when the first became entangled in New Jersey and Pennsylvania snags. The second compact, if not equally in the snags, is just as effectually blocked as the first through legislative inaction of the same two states; and so it must remain until 1929, when the Pennsylvania legislature meets again.

New York City, being either in more urgent need for more water than Philadelphia and the New Jersey municipalities, or feeling the need more strongly and being better organized to meet it, has decided to wait no longer for the tri-state compact but, if its Board of Water Supply is supported by the Board of Estimate, which seems likely, to go at once to the Delaware River watershed. Its plan to this end is admirably conceived to meet interstate conditions, as appears elsewhere in this issue. The plan not only keeps clear of the main stream, but is confined to the headwaters of Delaware River tributaries wholly within the state, nowhere less than 30 miles from the Delaware. Moreover, of 2,389 sq. miles of Delaware River drainage area in New York State, the plan proposes to tap only 600. Still further, it will take only flood flows from that area and, to make its position as regards interstate complications stronger yet, New York will release so much stored flood waters during dry weather that more water will pass down the tributaries than would flow there if the city had not built reservoirs to store and aqueducts to divert flood waters.

Numerous citations from U. S. Supreme Court decisions (in the Board of Water Supply report, but not reprinted in our article) make plain that New York City would be well within its established constitutional rights to a share in the beneficial use of this interstate stream, all the more so because the water is to be diverted for domestic use.

Whether spurred by the New York City plan or through coincidence, a few days after the plan was made public it was announced that the cities of Newark and Elizabeth, N. J., had agreed verbally to join in what is known as the Chimney Rock project, as outlined and advocated by Messrs. Pratt and Sherrerd, engineers for the North Jersey District Water Supply Commission. This plan involves water diversions successively to the westward until the main stream of the Delaware is tapped.

We are glad to see that New York City now proposes to act in accordance with the dictates of good engineering and the rulings of the U. S. Supreme Court. If New Jersey communities proceed along the same general line some day Philadelphia may arouse from its lethargy in additional water supply matters and start on a plan to take more water from the Delaware watershed. By then—or perhaps before—the New Jersey and Pennsylvania legislatures may follow the legislature of New York in ratifying the tri-state compact, unanimously adopted by commissioners from the three states on the advice of eminent attorneys and engineers from each state. However that may be, the long expected advance to the Delaware by New York City and Metropolitan New Jersey has begun in earnest and seems bound to succeed.

Municipal Tax Dollars and Budgets

EVERYONE with an inquiring mind likes to know how his tax dollar is distributed among the various objects of municipal expenditure. A well framed budget either gives the information or else paves an easy way to get it. Detroit has such a budget and the Detroit Bureau of Municipal Research, in its bulletin, *Public Business*, attempts each year to make clear to the average man and woman just what the budget means. The detailed items and explanations are preceded by a summary headed: "Your tax dollar is spent by the City of Detroit for the following services." Then follow main entries, ranging from $17,301,594 for public schools to $151,696 for the Recorder's Court and the corresponding percentages of the total tax levy of $76,030,836.

The summary is good as far as it goes but, presumably through no fault of the bureau, it does not go far enough. Thus, debt redemption and interest, totaling $14,357,729 or 18.88 cents of the tax dollar, should be distributed among many of the other 21 items to show fully how the tax dollar is used. It is subdivided under general city, school and library, making it possible for those who wish to add to the school and library items their share of the capital charges, but there remains over $8,000,000 or 11.43 cents of interest and sinking fund charges undistributed.

Dealing now with the division of the tax dollar only, and adding to the 22.76 cents levied for schools the 3.26 and 3.86 cents for redemption and interest on the school debt, there results 29.88 cents out of every dollar of tax levy in Detroit that goes for public schools. After schools and total debt charges, totaling 41.64 cents comes police protection, with 11.76. Of the remaining 59.36 cents of the tax dollar, various engineering and allied works and service take 26.5 cents, altogether—with no allowance for their part of the debt interest and redemption.

The last-named figure comes far from showing how large a part of municipal expenditures goes for engineering and allied work, for besides including bond interest and redemption charges here, a considerable part of the school disbursement is for engineering, and besides, only the tax dollar has been considered thus far. In addition to the $76,000,000 that the tax levy contributes to the Detroit budget there is well towards as much more, or $64,000,000, from miscellaneous revenue and from bond issues, much of which goes for engineering construction. Nor does the tax dollar, as analyzed, include anything for self-supporting departments—water, street railways, markets, buildings and safety engineering and house of correction—almost wholly engineering in character, expenditures considered.

The foregoing figures and comments indicate that, praiseworthy as the Detroit budget and the bureau an-

alysis of it are, they leave much to be desired by anyone who wishes to know how the sum total of city revenue is apportioned among departments, functions or objects. Presumably, the budget carries items that could be recombined for some of these purposes, but unless Detroit is an exception among cities, much of the original cause of indebtendness, with corresponding interest and sinking fund charges, is now obscured, having been merged in more or less general bond issues, original or refunding. All the limitations mentioned in this discussion, and many others, are true in varying degrees for every city in the country. Municipal budgets and reports have still a long way to go before they will answer all the questions a reasonably inquiring taxpayer may wish to have answered.

Advancing Needs

HUMAN achievement is called upon for ever greater effort by the growth of the world's needs. Today it is required to build the gigantic bridge over the Hudson, 3,500 ft. or two-thirds of a mile from pier to pier, whose technical features are made known for the first time in this issue. Engineering progress usually goes forward cautiously, step by step, but here we see a sudden leap forward into a wholly new range of magnitude. A year ago the Delaware River bridge at Philadelphia was put into service, its span of 1,750 ft. taking rank with the world's greatest; yet even now the workers are building the foundations for a bridge of twice its span. Man needs the bridge. It will speed his comings and goings and render him more efficient; and so, though it calls for performance beyond precedent, it is built.

Until now there has been only vague knowledge concerning the remarkable enterprise. Planning has been under way for two years. Long before it was finished, legislatures and bankers gave millions toward the realization of the project, with commendable faith in the ability of engineers to accomplish the unprecedented. Yet one heard only some general figures of span and cost, with little tangible fact as to details. There were good reasons for this reticence. The plans were in a state of flux; oft-repeated restudy of the conditions and available solutions of the problem was going on. Now that the major decisions have been made and final forms well crystallized, the project appears in definite form.

It is seen to be concretely practicable and sanely projected, despite its heaven-aspiring boldness. Its methods, materials and forms are such as man has well mastered. New and fascinatingly interesting features appear at every point, it is true, but they involve only skillful adaptation of that which has been learned from past works and experiences. The undertaking is feasible and dependable; it is in no sense a venture into the untried, the reaching out into the dark which its huge bulk would suggest. Much as we may wonder at the massive supports, the 36-in. cables or the massed eyebars, it is plain that all are well-known and tried elements, assembled in well-understood aggregates by known tools and procedures. Piers, towers and cables, suspenders and roadway are familiar objecs of engineering construction.

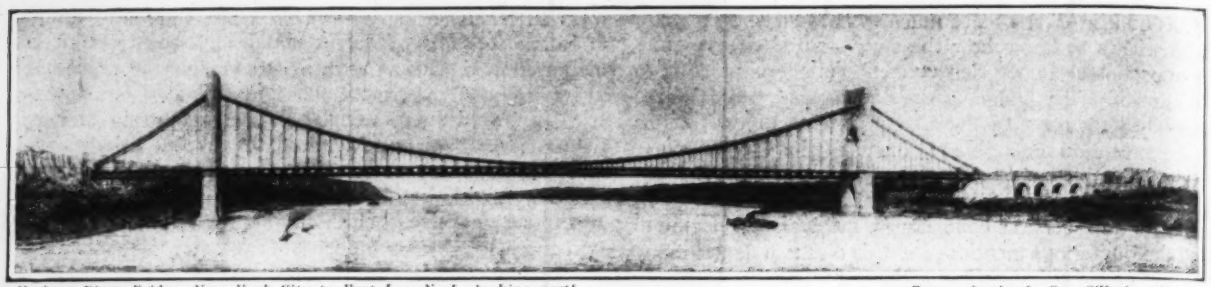
It is indeed astonishing to realize that so great a leap forward in size involves so little of the absolutely new. A reason for this may lie in the fact that we are concerned with a suspension bridge, a type of structure whose problems and difficulties by no means bear direct ratio to length of span—within wide, indefinite limits at least. The art of suspension bridge construction is measured as much by the capacity of industrial processes as by bridge engineering skill. The power of our industries in producing materials, in manufacturing and in field construction, has advanced so far that bridge construction has not yet tested it to the limit. Who will say but that for its day, half a century back, when industry was more primitive, the building of the Brooklyn Bridge told more heavily on human courage and determination to try the untried than even the present huge undertaking? The engineer's tasks are immeasurably more severe in extending the range of the cantilever than that of the suspension bridge. One may think back to Baker's pathless pioneering in constructing the Forth Bridge, and have some measure of attempting the impossible.

Yet one of the burdens of the present enterprise has been the doubting of those who looked anxiously back at past performance and questioned the bold proposal because of its size. They conjured up manifold apprehensions and tended to raise up the belief that this thing could not be done, or in due safety should not be done. Fortunately such attitudes of mind are not apt to survive the open statement and discussion of fact. Publication of the principal engineering features of the projected work will help to lay the last of these ghosts.

It is of value to recall at this time, too, that the Hudson River bridge project had to overcome certain obstacles far greater than engineering difficulties. The invisible state line which passes down the thread of the river was one of these. Another was a curious but tenacious opposition of influential elements in New York's public life to any connection with the opposite bank of the Hudson by which a freer flow of human traffic might be brought about. This insularity marked itself in many ways, and even employed serious technical argument. It urged at one moment the hopeless impossibility of building a bridge, or paying for it, at another the necessity of keeping New York's streets free from the congestion of visiting traffic. But in every guise it was mere insularity. The eyes that had never seen the Hudson bridged could not conceive of it as a real and serviceable achievement. That spirit is now of the past, fortunately. It could not survive the new pressure of the modern traffic era and its demands for freer movement over the face of the earth.

Aside from its phases of general public interest, its significance to the growth of the New World metropolis, its great cost and the prospective early return of that cost, the enterprise presents quite as weighty engineering matters for discussion. But we take time to mention only one of these at present. This is the matter of building for permanence.

All our ordinary bridge construction is based on a relatively short view ahead—forty or fifty years at most. The rapid change of the world hardly warrants thinking of longer periods; obsolescence comes so fast that we rarely need seek the enduring. But when we contemplate a work of such size and cost as the Hudson River bridge our perspective must inevitably lengthen far. That structure is planned, by today's best lights, for service of lasting efficiency. Its capacity has been adjusted to the probable needs of the long distant future as well as of today. We must then, it is clear, apply the same long view to the structure itself. It, too, must be built to endure, not decades but centuries.



Hudson River Bridge, New York City to Fort Lee, N. J., looking north *From a drawing by Cass Gilbert, architect*

Design of 3,500-Ft. Suspension Bridge Across Hudson River

Huge Public Toll Bridge to Connect New Jersey with New York City—To Be of Suspension Type, Using Either Wire or Eyebar Cables—Stiffening Trusses and Lower Deck Will Be Omitted in First Stage of Construction—Long-Panel Floor Framing

(With insert plate)

THREE months ago construction began on what will be by far the largest bridge in the world. It is a highway crossing over the Hudson at New York City, connecting the city with the suburban region of northern New Jersey, and extends from Fort Washington Point, in the northern part of the city, to the borough of Fort Lee on the New Jersey side. It is to be a suspension structure of one span, 3,500 ft. between main towers, nearly double the span of the 1,800-ft. Quebec cantilever and exactly double the 1,750-ft. Camden-Philadelphia span. Although a public structure, it is to be operated on a toll basis.

The Port of New York Authority is constructing the bridge at the direction of the legislatures of the states of New York and New Jersey. The work is financed by an initial appropriation from the two states and an issue of Port Authority bonds. The cost of the structure will probably approach $75,000,000 in its final stage, but it is thought that only about $55,000,000 to $60,000,000 will need to be spent by the time the bridge is opened for traffic, with the initial section of the ultimate roadway width in place.

During three years the project has been under study by the engineering staff of the Port Authority, at the specific direction of the two states. Following a favorable preliminary report a year and a half ago, the legislatures in 1926 made a first appropriation of $1,000,000 each (with the declaration that four subsequent appropriations of similar amount would be made available), to form the nucleus of the financing, and the Port Authority was directed to proceed with the construction of the bridge on the basis of these funds and an issue of its own bonds secured by the toll revenues to be derived from the operation of the bridge. Just as in the case of the two bridges connecting Staten Island and New Jersey across Arthur Kill, which the Port Authority had previously been directed to build, and which are now nearing completion, the state specified that traffic over the bridge shall pay tolls to cover the interest and amortization of the bonds and return the state contributions. Following this legislation, the Port Authority last December obtained approval of the War Department for its proposed span and clearance height, and immediately thereafter authorized an issue of $60,000,000 of bonds and sold a first lot of $20,000,000 to a banking syndicate on a basis of approximately 4¼ per cent.

Since that time the development of final plans has been in progress, and early in the current year had progressed far enough to permit letting a contract for the west or New Jersey main pier. This pier is now

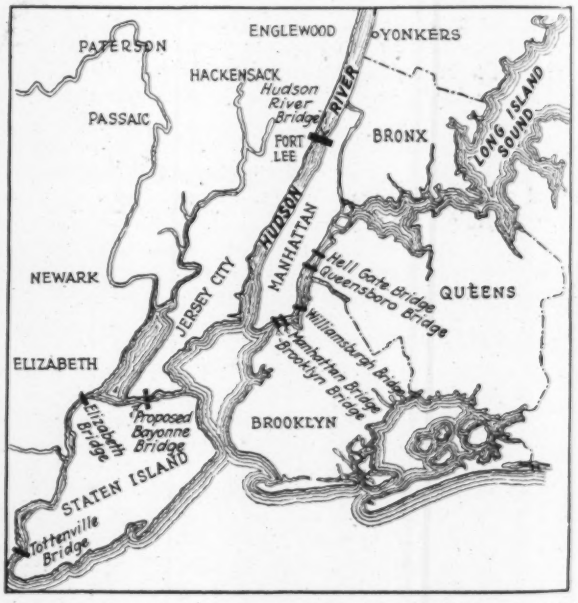
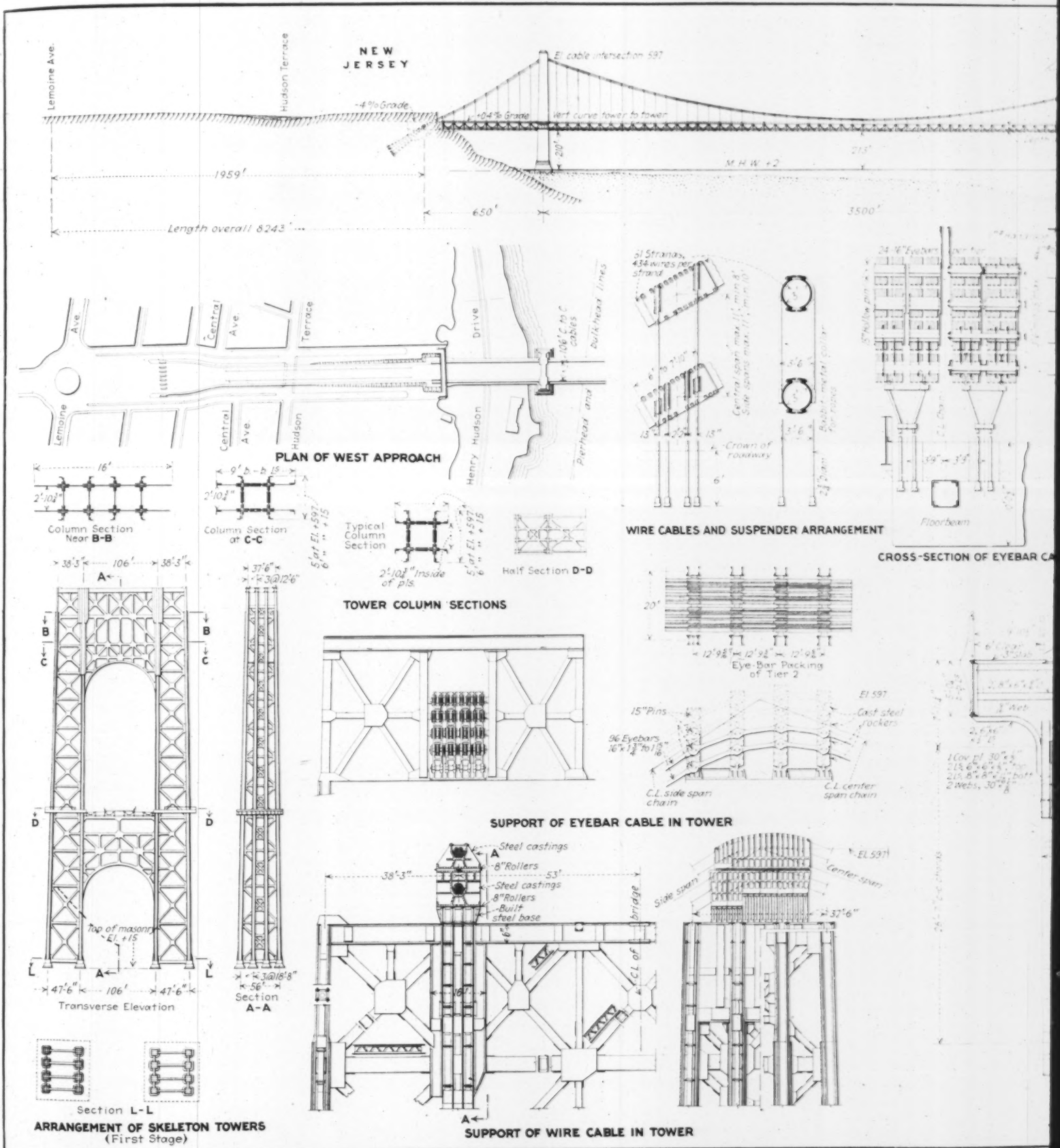


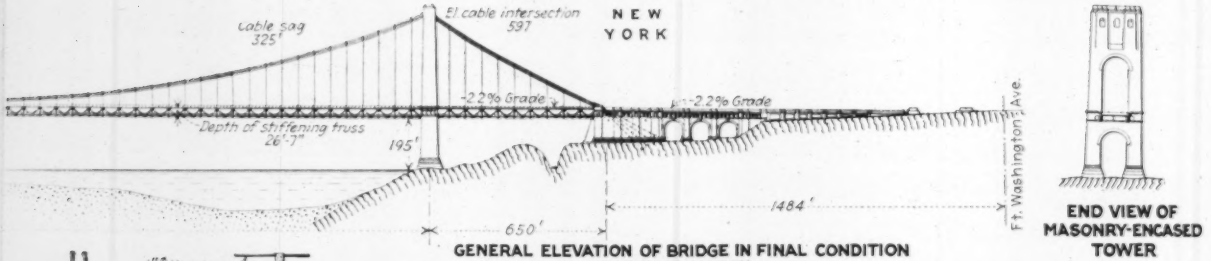
FIG. 1—HUDSON RIVER BRIDGE IN RELATION TO NEW YORK METROPOLITAN DISTRICT

under construction, as are also the anchorage and approach cut in the Palisades on the New Jersey side. Development of superstructure plans has now progressed so far that a call for bids upon the entire steel superstructure is expected to issue within the current month.

Genesis of Project—The Fort Lee bridge project has a long historical background. Bridging the Hudson in its wide reaches past New York City by a great single-span structure has been advocated and studied for more

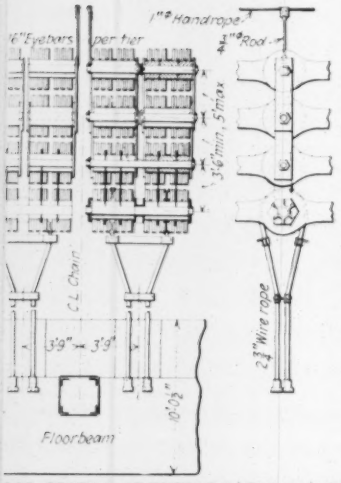


Principal Construction Features of 3,500-Ft. Suspension Bridge Across the Hudson Rive

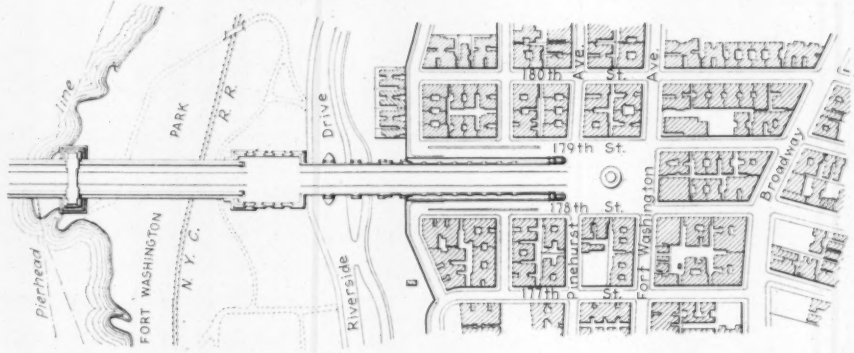


GENERAL ELEVATION OF BRIDGE IN FINAL CONDITION LOOKING NORTH

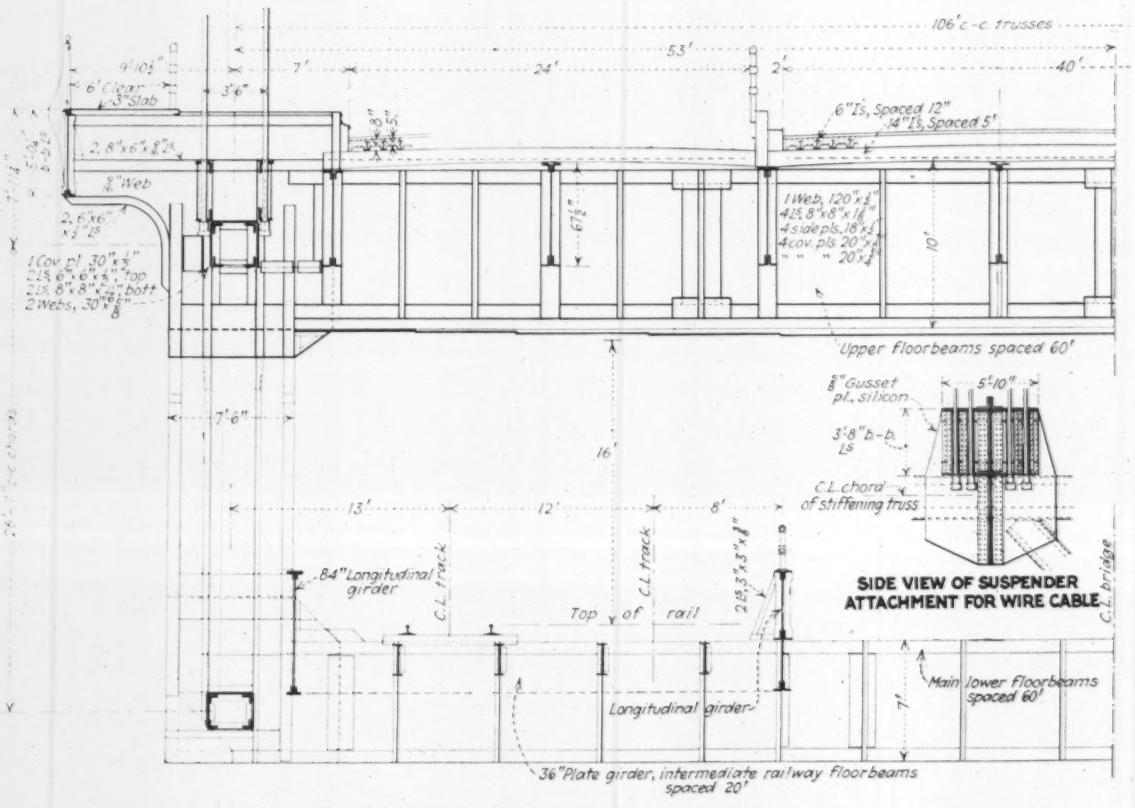
END VIEW OF MASONRY-ENCASED TOWER



OSS-SECTION OF EYEBAR CABLE AT SUSPENDER



PLAN OF EAST APPROACH



SIDE VIEW OF SUSPENDER ATTACHMENT FOR WIRE CABLE

HALF CROSS-SECTION OF DECK (Second Construction Stage Shown in Fine Lines)

s the Hudson River Between New York City and Fort Lee, N. J.

than thirty years. A project for a bridge at 57th St., developed by Gustav Lindenthal, as the final outcome of planning dating back to the '90s, is even now in an active stage. This and other projects had in view direct access to the heart of mid-town New York. But in 1910 the Interstate Bridge and Tunnel Commissions, a joint body of the two states, looked some six miles farther north, to the Fort Washington-Fort Lee narrows, and outlined a tentative plan for a cantilever bridge with river piers. Thereafter it proceeded to investigate foundation conditions by borings, and then found that no rock was within reach over a width of more than 3,000 ft. This disappointing discovery caused the commissions to conclude that any Hudson River bridge within the limits of New York City would have to cross the river by a single span—which meant 3,000 ft. or over. With this conclusion it abandoned further consideration of the Fort Lee site.

From that time on no attention was given to this site until 1923, when O. H. Ammann, now bridge engineer of the Port of New York Authority, made a study of

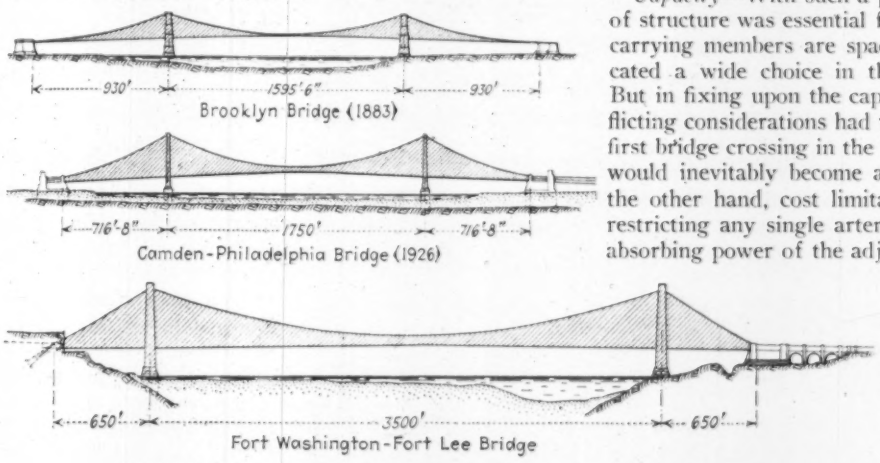


FIG. 2—THREE HISTORIC SUSPENSION BRIDGES COMPARED

the possibilities of the site, and recommended construction of a single span suspension bridge on the present location. The proposal obtained such popular support that a year later the legislatures of the two states authorized the Port Authority to study its possibilities. The resulting preliminary report, rendered in the early part of 1926, showed that the crossing was physically feasible and would pay for itself on a toll basis. The legislative decision to proceed with the work then followed.

Site—How the new bridge is related to the general territory of New York City and its neighbors immediately to the west is brought out by the regional map, Fig. 1. Its direct street connections are shown in connection with the general plan on the insert plate facing p. 212. At the east end the bridge ties into the general street network of the Washington Heights residential region of New York City and has ready connection with the Washington bridge across the Harlem River, leading to the Bronx and to the outward roads north and east. On the west side it taps several main highways, though more complete approach routes will probably be developed in the future.

Both banks of the river in the region of the bridge are rock ridges, 200 to 300 ft. high above tide, with crests from 500 to 1,500 ft. back from shore. Rock is exposed on the New York or east bank, forming a rocky cape, Fort Washington Point, whence it shelves down steeply to the navigation channel. On the New Jersey side rock slopes down more slowly, and reaches a depth of about 150 ft. below water at the pierhead line. Except at the shores, throughout the 3,200-ft. width between pierhead lines the rock surface lies below the depth of 200 ft. The overlying material ranges from soft mud to plastic clay.

These conditions of site and topography dictated the general layout—a single span of at least 3,200 ft., suspension type, and a clearance height of about 200 ft. Navigation interference was not a factor under these circumstances. Detail study of foundation possibilities placed the east pier above water on Fort Washington Point, and the west pier 100 ft. back of the pierhead line, where rock was at less than 100-ft. depth and the foundation could therefore be examined in the dry (the pneumatic process being available at this depth if found necessary). These positions fixed the main-span length at 3,500 ft. between centers of towers.

Capacity—With such a prodigious span, a great width of structure was essential for lateral stiffness. The main carrying members are spaced 106 ft. apart. This indicated a wide choice in the matter of traffic capacity. But in fixing upon the capacity to be provided for, conflicting considerations had to be faced: the fact that this first bridge crossing in the lower 50 miles of the Hudson would inevitably become a great traffic artery, and, on the other hand, cost limitations and the desirability of restricting any single arterial crossing to the reasonable absorbing power of the adjacent street network.

The future traffic function of this bridge, elaborate studies made by the Port Authority staff and the Regional Plan of New York and Vicinity indicate, is certain to be many times greater than its importance in the next decade or so, since the crossing will form an active ingress and egress route for New York, will be the main bypass route in the coastal highway system around the central part of New York City, and will connect the rapidly growing and highly important Westchester County suburban area with equally important New Jersey residential areas. Nevertheless, it was concluded that a traffic capacity of eight highway lanes, supplemented by a smaller number of rapid transit tracks (or possibly bus lanes or ordinary traffic lanes) represents a reasonable maximum to be concentrated in this single arterial connection. A plan has accordingly been worked out to provide eight highway lanes in one width, on an upper deck, and from four to six tracks or lanes on a lower deck. Comparison with the capacity of a few other great urban bridges is given by Fig. 3.

Cost considerations, however, at once entered into the matter here. Were the bridge to be built for full capacity from the beginning, many millions of dollars of investment would not be utilized for a number of years. Accordingly, the idea of building the towers, cables and roadway in two stages—first for half capacity and later for full capacity—was embodied in the preliminary plan, and was retained in the final plan. It has now been modified, however, by the decision that towers and cables shall be built to full capacity initially,

while the two-stage plan is retained for floor and stiffening trusses.

General Design—Various elements of the general design of the bridge are determined by the local topography, as already indicated. Not only is the position of piers closely fixed by the ground conditions, but the length of side spans is similarly determined within narrow limits. On the New Jersey side, the Palisades cliff naturally terminates the side span and at the same time provides ample anchorage facilities; anchor chains bedded in deep tunnels driven diagonally 250 ft. into the cliff are contemplated. On the New York side the ridge is farther back, but the ground permits building a masonry gravity anchorage at a point that makes the two side spans equal and the bridge therefore symmetrical in appearance. Continuing the roadway thence eastward to the high ground by means of a masonry viaduct proved to be cheaper than attempting to span this entire distance by a prolongation of the suspended structure, an expedient which would produce an unsymmetrical structure and would have the further disadvantage of increasing the flexibility of the structure and therefore making its strains considerably more serious, besides requiring provision for large movements of the cables at the top of the east tower.

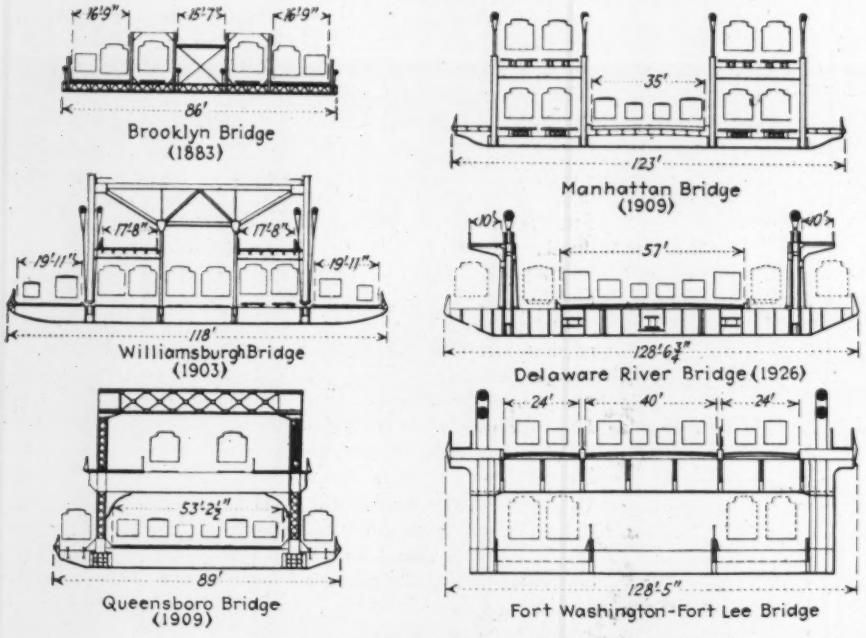


FIG. 3—TRAFFIC FACILITIES OF SIX GREAT CITY BRIDGES

The proportioning of the cable catenary was determined mainly by esthetic judgment, the economic balance being reasonably even over quite a range of sag ratios. The ratio selected, about 1:10.8, makes the span slightly less flat than that of the Brooklyn bridge and slightly flatter than those of the Williamsburgh, Manhattan and Delaware River bridges.

The relatively short and steep side span cables constitute fairly rigid backstays. Rigidity here is advantageous because it minimizes the movement of the cables at the tower top necessary to equalize the horizontal stress components in main and side spans. Because of the span proportions, the side-span rigidity is but little affected by supporting the side-span roadway from the cables, and this arrangement, with its economic and esthetic superiority over inde-

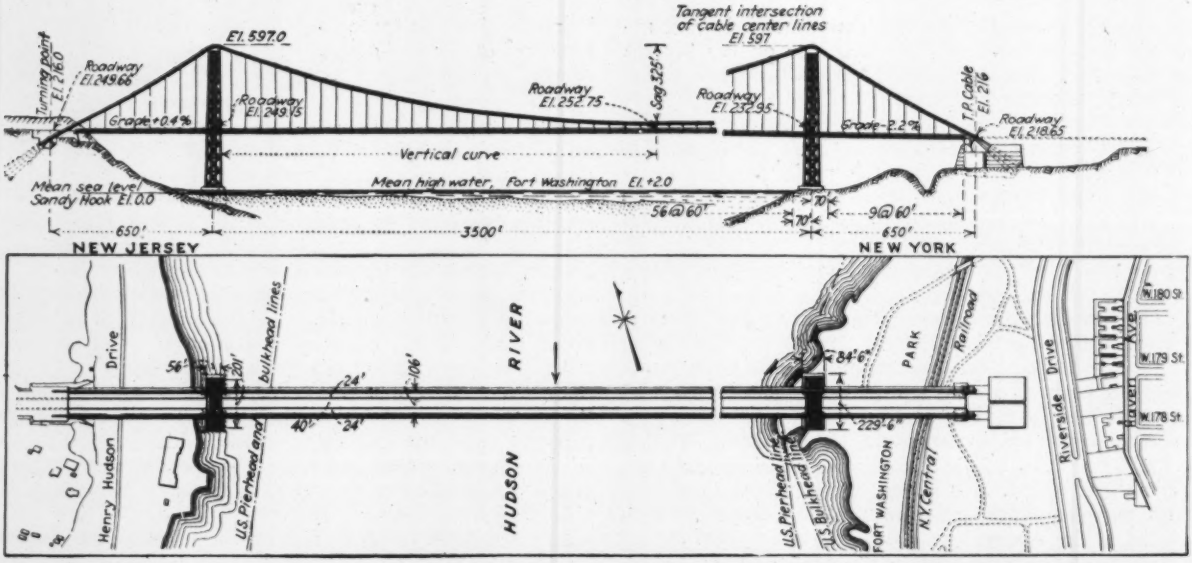


FIG. 4—INITIAL CONSTRUCTION STAGE OF FORT WASHINGTON-FORT LEE BRIDGE (APPROACHES NOT SHOWN)

In the first construction stage the full tower and cable capacity will be provided, but the concrete and stone encasement of the towers will be omitted. Only the upper deck will be built in this stage and the stiffening trusses will be omitted, except for the upper chord, which will serve as the chord of the horizontal wind truss in the plane of the roadway floor.

pendent support, was adopted. The esthetic effect is portrayed in two architect's sketches reproduced here.

Cables—The determinative features of the huge suspension bridge, naturally, are the cables, the towers, and the stiffening system and associated main floor construction. All of these features have been the subject of unusually extensive studies on the part of the engineers who developed the design, and the subject also of much criticism and discussion outside.

For the main supporting cables, the possibility of using either high-strength forged eyebars or parallel-wire cables of the conventional type has been kept in view from the outset. Exhaustive studies have shown both types of structure to be feasible and satisfactory, being capable of rapid construction by known processes, and being dependable and permanent in service. Alternative designs for the two types were therefore worked out at an early stage of the development, with a view to calling for competitive bids. This decision has been adhered to, after repeated restudy of the designs in the light of various criticisms, directed mainly against the eyebar cable.

The two kinds of cable necessarily will have different weight, the eyebar cables being about 2½ times as heavy as the wire cables. While this increased weight is an advantage in point of rigidity, the two designs have been worked out to the same outline and the same stiffening-truss proportions, without discrimination on the score of comparative stiffness.

For either type of cable, sizes much larger than anything previously attempted will be involved. In the case of wire cables, there will be four cables 36 in. in diameter, two cables on each side of the bridge, one directly above the other (forming a single two-cable carrying member). In the case of eyebar cables, each side of the bridge will be carried by eight groups of twelve eyebars averaging 16 x 2 in., arranged in four tiers comprising 96 eyebars, attaining a maximum of 3,456 sq.in. of carrying section. Both forms are so developed that two-stage construction is possible, the lower half of the cable being built first and the upper half later.

As previously noted, two-stage construction was a feature of the first plan for the bridge, with a view to postponing for five or ten years an expenditure ranging from $15,000,000 to $30,000,000 and thereby saving a very large sum by reduction of interest. As concerns the cables and towers, however, a thorough review of the facts of the situation early this summer led the engineering staff and its consulting engineers to conclude that they should be completed to final capacity by the time the bridge is opened to traffic, although they might as a matter of the constructor's convenience be built in two successive operations, the second half being erected while the floor construction is going on. Accordingly, alternative bids will be asked on construction of the cables in one stage or two (the second stage to be completed before the bridge is opened to traffic).

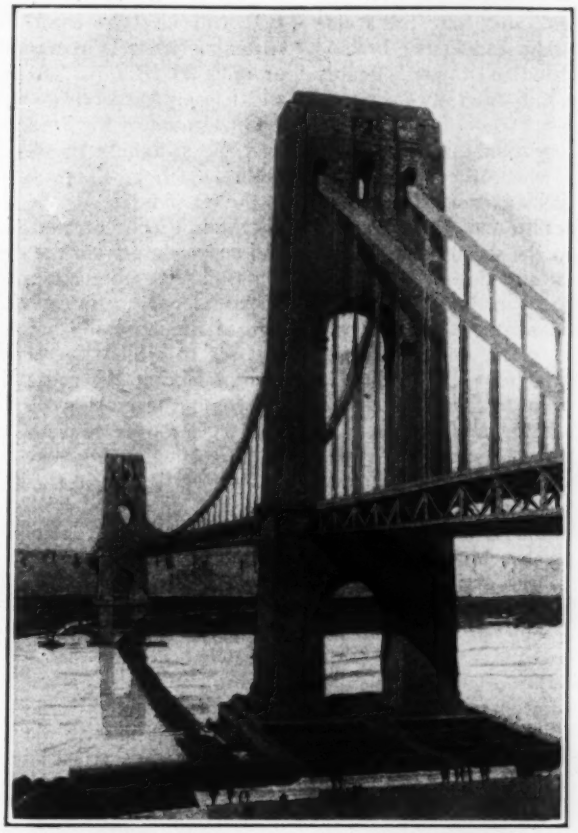


FIG. 5—PERSPECTIVE DRAWING OF FORT WASHINGTON-FORT LEE SUSPENSION BRIDGE NOW UNDER CONSTRUCTION

Steel towers support the saddles, but the steelwork is to be encased in stone-faced concrete. The roadway is a double-deck structure, with ultimate provision of eight lanes for highway traffic on the upper deck. The floor is supported by two cable groups, which may be of either parallel wire or eyebar construction. In the case of wire cables, each group will consist of two separate cables 36 in. in diameter. The towers will reach a height of 625 ft. above water.

The suspenders and their attachment to cables and floor have been studied almost as fully as the cables themselves. They present a problem somewhat different from that found in prior suspension bridges because of the use of two cables on either side of the bridge and because of the unusual floor panel length, namely 60 ft. (as compared with previous extremes of 7½ ft. in the Brooklyn bridge and 20 ft. in the Delaware River bridge). The adopted hanger constructions are shown by details on the insert plate accompanying this issue. Rope suspenders were chosen for both types of cable, the ropes resting on cable bands of the usual form of construction in the case of wire cable, and being looped over pin-spools in the case of the eyebar cables.

One factor that determined the adoption of rope suspenders in the latter case was the importance of a large degree of lateral flexibility in the suspender. Since the bridge floor is so narrow compared with the great span length that it will be quite flexible laterally, while the heavy cables are relatively resistant to wind deflection, a large part of the wind load will be transmitted to the cables by way of the suspenders. On this account it is necessary that the suspenders be capable of assuming a sidewise inclination sufficiently large that the horizontal component of suspender pull will transfer the wind shear from floor to cable without bending the suspenders. The lower ends of the suspenders in both instances are attached to the floorbeams by having their end sockets engage stiffened brackets on the sides of the floorbeams.

Towers—Esthetic considerations played a large part in the determination of all the general features of this bridge. They were most commanding, perhaps, in relation to the towers. Cass Gilbert, the noted architect, was called into consultation from the earliest stages of

the Port Authority planning, and has been active in developing the architectural features and ornamentation of the bridge throughout. He agreed with the engineers in favoring a masonry-encased steel-frame tower. The form developed is, in side elevation, that of a slender, gently tapering shaft, plain in outline and marked by only enough vertical relief to emphasize its function and size. Seen in the direction of the bridge axis the tower is broad, and is cut by a lofty vaulted passage through which the roadway passes. Structurally, the great pier is a cellular assemblage of reinforced-concrete walls surrounding and encasing a steel tower comprising two groups of eight columns and four transverse planes of truss work, assembled by connecting bracing and horizontal diaphragms into a unified tower. Beauty and permanence are served by an exterior facing of stone.

It was planned at first to proportion this tower as a concrete-and-steel structure, in which the steel would support the loads of the first construction stage (half roadway capacity) and the concrete and stone, applied later, would carry a large part of the second-stage loads. This ingenious construction plan and design have been under discussion quite as animated as that centered on the question of eyebar or wire cable. Criticism was mainly based on the claims that plain, uncovered steel towers (Manhattan bridge type, later used in the Philadelphia-Camden bridge) are superior to composite towers both economically and structurally, that the use of masonry architectural form for a structure whose strength depends mainly on the steel framework violates esthetic principle, and that the load distribution through the composite tower would be indeterminate. Repeated and thorough restudy of the towers, however, has led to the retention and approval of the original design in all substantial features with only one major change, namely, strengthening the steel skeleton so that it will be able to carry the complete final loads, both dead and live, leaving the concrete and masonry encasement to serve as permanent weather protection and architectural dress, though it will also give the tower a greater marginal strength and thus provide amply for possible future increase in carrying capacity.

This change, determined upon only within the last three months, resulted in part from the growing recognition in the course of the engineering studies that the initial traffic demand may prove unexpectedly heavy, taxing the initial roadway capacity almost at the outset and making it necessary to construct the additional roadways immediately after opening and before there would be time to build the inclosing shell of the towers. In part, also, the decision constituted a recognition of the wholly exceptional psychological factors surrounding a structure of a size so far beyond precedent. It was felt that such ample guarantees of strength should be provided in these huge towers that immediately upon its opening the bridge would be sure to engage complete public confidence. These views also influenced the decision in favor of constructing the full ultimate cable capacity at once.

Stiffening Truss—In the Fort Lee bridge, for the first time in the modern construction of large suspension bridges, the stiffening truss assumes a very minor position. The great span length and the resulting weight of cables and floor result in a large inherent stability of the structure against deformation, while on the other hand the distributed nature of highway traffic means a small deforming moment. No stiffening truss is considered necessary, therefore, in the initial construction stage for vehicular traffic, but the action of a stiffening truss is believed to be desirable when and if trains are run over the structure.

Combining these conclusions with the plan to construct two decks, the upper or highway deck built in the initial stage and the lower or rapid-transit deck in the second stage, the design provides for placing in the first stage only the upper chord of the stiffening truss (serving as chord of the wind truss), and adding the web members and bottom chord when the lower deck is added.

It will be seen from the general drawing that the stiffening truss is remarkably shallow, having a depth of only 26 ft. 7 in. It is discontinuous at the towers and has uniform cross-section throughout a span.

On account of the great length of span and large dead-load the stiffening trusses have little effect in resisting cable deflection. They become necessary as an adjunct to the construction of the lower deck and are effective in distributing concentrated loads, thus relieving the cables and suspenders from the direct action of such concentrations and preventing local distortions of the cables and floor under the action of train loads especially. The design of the stiffening trusses consists in finding the unit stresses to which the deflections of the cables subject them. Fixing the areas of the chord sections of the trusses is therefore a matter of selecting nominal sizes that will produce efficient compression members, the size of the section having very little effect on the unit stresses.

Both vertical deflections due to live-load and temperature and lateral deflections due to wind forces are taken into account. The combined unit stress as found for the worst case of loading in each span determines the grade of steel used. For the eyebar design the chords are of carbon steel in the side spans and silicon steel in the center span, while for the wire cable design, with its somewhat greater deflection, the chords are of silicon steel in the side spans and nickel steel in the center span, with correspondingly higher unit stresses.

In connection with the bridge cross-section, shown on our insert plate, attention is called to the fact that in the upper deck there is a main stringer system, transverse subfloorbeams at 5-ft. spacing, and a reinforced-concrete slab spanning this distance with the aid of longitudinal reinforcing members embedded in the concrete. The main floorbeams, as already stated, are spaced 60 ft. A lateral bracing system is included in the floor, in the plane of the top flanges of the stringers, forming with the stiffening-truss chord a complete wind truss. The lower deck has intermediate floorbeams at 20-ft. spacing carried by longitudinal plate-girder main stringers spanning the 60-ft. panel between main floorbeams.

Three roadways occupy the upper deck, designed to accommodate two, four and two highway traffic lanes respectively. It is intended to build the central four-lane roadway first, adding the side roadways only when traffic increase demands. The lower deck as originally designed comprised brackets extending out either side of the stiffening-truss posts for a sufficient distance to accommodate a single-track width of deck. The finally developed design, however, provides a full floorbeam for the lower deck in place of the bracket construction, mainly to increase the convenience and adaptability of the lower deck for four or more tracks or other lanes of traffic. This construction is slightly more costly and involves greater dead-weight than the bracket construction,

but is believed to offer sufficient advantage to make this extra expense worth while.

Materials—Silicon steel is used generally for the main columns of the towers and for the main material in the floor system. Carbon steel is used generally for the tower bracing and tower and floor details. The cable eyebars (if used) will be heat-treated eyebars with a minimum ultimate strength of 105,000 lb. per sq.in. and minimum yield point of 75,000; they are proportioned for a working stress, including secondary stress, of 50,000 lb. per sq.in. The wire cables (if used) will consist of No. 6 galvanized wire having a minimum ultimate strength of

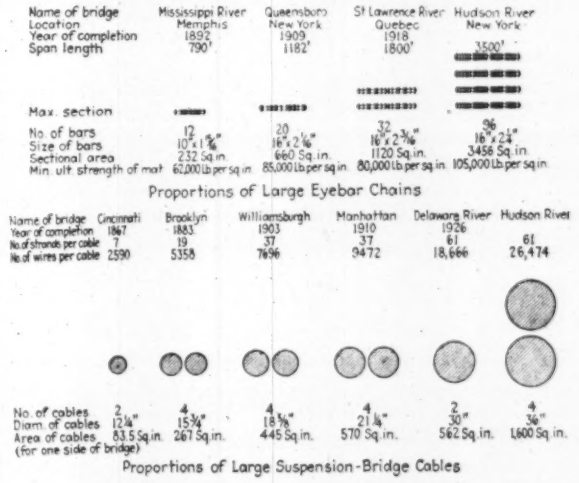


FIG. 6—SOME NOTABLE BRIDGE CABLES AND EYEBAR CHAINS

220,000 lb. per sq.in. and minimum yield point of 150,000; their working stress, exclusive of secondary stresses, will be 82,000 lb. per sq.in. The grades of steel used in the stiffening trusses have already been mentioned.

Loads—The final dead-loads for the eyebar-cable design are 50,000 lb. per lin.ft. in the center span and 56,000 lb. in the side spans. For the wire cable design they are 39,000 lb. per lin.ft. in the center span and 40,700 lb. in the side span.

Live-loads on both roadway and track spaces were taken at figures corresponding to the heaviest modern traffic. Because of the effect of longitudinal distribution, their equivalents in load per lineal foot of bridge, as used in proportioning the floor system, suspenders, stiffening trusses and main carrying members, vary with the loaded length and number of lanes involved. Thus in the design of the stringers, where load on only one 60-ft. panel is concerned, the system of loading is such as to represent a live-load of 31,000 lb. per lineal foot of bridge (both decks, ultimate condition). In the floorbeam design (two panels of both decks loaded) this figure becomes 26,000 lb., while in the suspender design (five panels loaded) it reduces further to 18,000 lb. For the case of load on the full 4,800-ft. length of bridge, as in the proportioning of cables, towers and anchorages, the equivalent average load becomes 8,000 lb. per lineal foot of structure.

Construction Program and Organization—Contracts have already been let for two items of the bridge, and work on them has been in progress for some months. The foundations for the west (New Jersey) tower are being built by Silas B. Mason, on a bid of $1,160,000. The west anchorage and approach cut excavation, in rock, is being done by Foley Bros., on a bid of $694,000.

These two contracts are to be completed next spring and next fall respectively. In the meantime the contract for the superstructure steelwork will have been let; bids are to be asked within the current month. The east anchorage contract is expected to be let early next year. Erection of the towers should begin next summer. The program calls for completing the bridge and opening it to traffic early in 1932.

The design and construction of the bridge are being carried out by the engineering staff of the Port of New York Authority. J. E. Ramsey is chief executive officer. O. H. Ammann, bridge engineer, with E. W. Stearns as assistant, is in general charge of the design and construction. L. S. Moisseiff is advisory engineer of design and Allston Dana is engineer of design. Traffic matters are in charge of Robert A. Lesher, traffic engineer. Field operations are under M. B. Case, engineer of construction. The work is being done with the assistance of Prof. William H. Burr and Gen. George W. Goethals, consulting engineers, Daniel E. Moran, consultant on foundations, and Cass Gilbert, architect.

Southern Land Reclamation—A Report on Possibilities and Methods

WHAT can be done in land reclamation and settlement in the southern states has been studied by the Bureau of Reclamation under direction of Congress. The principal study was made for the Bureau by a board of special advisers, composed of Howard Elliott, Daniel C. Roper, and George Soule. Each of the southern states was asked to designate a tract of land available and suitable for group settlement after reclamation, and the tracts so selected were then studied by the board in conjunction with specialists from the Bureau of Reclamation and the state officials and agricultural colleges. Tracts of 6,000 to 25,000 acres were submitted by North and South Carolina, Georgia, Florida, Alabama, Mississippi, and Tennessee. The required reclamation was found to consist of clearing, in some instances drainage, and usually breaking the land and putting it into an initial crop; the Florida tract, west of Fort Lauderdale, would require also pumping plants for permanent drainage. Individual farms ranging in size from 20 acres (Florida) to 120 acres (Alabama) are recommended, according to the type of product and cultivation suitable to the soil and climate. The crops contemplated are such as have a ready market and as will maintain and increase soil fertility, in due rotation. Each of the tracts in question will provide for 100 to 150 home-owning farmers.

It is recommended by the board that further study leading to the development of definite settlement plans be based on specific soil surveys; and that the settlement projects be worked out on the basis of expert planning and supervision, provision of money to enable settlers to complete the farm improvement and equipment on long-term loans at low rates of interest, centralized control of settlement, and co-operation in the work between state and federal bureaus.

Most of the land studied is idle or under unprofitable farming at present, the latter mainly because of tenant farming. The South Carolina, Georgia, and Alabama tracts are now being given further study by the Bureau of Reclamation and state authorities.

New York City Plans Going to the Delaware for More Water

Flood Flow of New York Tributaries with Low Stream Flow Increased from Storage, Advised by Board

AN additional water supply of 700 m.g.d. of which 600 m.g.d. would be from flood flows of tributaries of the Delaware River within New York State, and 100 m.g.d. from Rondout Creek, a tributary of the Hudson River, has been recommended by the Board of Water Supply, New York City. Construction in three stages is proposed. The estimated cost of the first two stages, which would give 510 to 540 m.g.d., is $272,587,000, or $75,347,000 less than the estimated cost of providing 434 m.g.d. from streams east of the Hudson, recommended by the board last October (see *Engineering News-Record*, Oct. 21, 1926, p. 670). Abandonment of the earlier plan is now advised because of changes in the status of the proposed tri-state Delaware River compact since the east-of-the-Hudson plan was submitted and the urgent need for more water by 1935. Both of these plans provide for turning the yield of the higher portions of the Croton drainage area into the existing Catskill terminal reservoirs, thus conserving head now wasted, the later planning thus turning 100 m.g.d. compared with 121 m.g.d. in the earlier plan. Before the new plan can be put under execution, it must be adopted by the Board of Estimate and Apportionment, New York City, then approved by the Water Power & Control Commission of New York State. In addition, the New York Legislature must amend its legislation of 1905, authorizing the construction of the Catskill system.

The following notes, plan and profile of the new project are taken from the report of Thaddeus Merriman, chief engineer, Board of Water Supply, dated June 10, 1927, and submitted to the Board of Estimate July 27 by the Board of Water Supply.

As the map shows, five storage reservoirs would be built in the upper reaches of tributaries of the Delaware River and a sixth reservoir on Rondout Creek. The aqueduct system necessary to bring the water thus stored to New York City is shown on the map. None of the dams on tributaries of the Delaware is nearer the main stream than 30 miles.

The first stage of construction will provide from 140 to 170 m.g.d. of additional water supply, besides delivering 100 m.g.d. daily of the present low level Croton water into the existing Kensico storage reservoir at the lower end of the Catskill aqueduct. The reservoir on Rondout Creek near Montela stores water from a drainage area of 100 sq. miles and yields from 70 to 100 m.g.d. The reservoir near Curry on the Neversink River will provide 70 m.g.d. from 70 sq. miles of drainage area. Aqueduct construction for the first phase of the project will include a tunnel one mile long connecting the Neversink and Rondout reservoirs and all the remainder of the aqueduct system shown on the map between the Rondout reservoir and the existing Hill View reservoir, totaling 87 miles of main aqueduct, mostly in tunnel, and 12 miles of aqueduct and pipe in the Croton system.

The second stage of construction, giving 370 m.g.d. of water additional and bringing the total new supply up to some 510 to 540 m.g.d., will be the construction of the East Branch reservoir, formed by a dam near Downsville impounding water from 370 sq. miles of drainage area; and a 22-mile tunnel from this reservoir to the Rondout valley.

The third stage, adding 160 m.g.d. and completing the system, will take in 50 sq. miles of drainage area on the Little Delaware River, with storage near Delhi, yielding 40 m.g.d., and 60 sq. miles each on Beaver Kill and Willowemoc Creek with storage near Beaver Kill and Parkston, respectively, each yielding 60 m.g.d. Necessary aqueducts will also be included in this stage.

If and as necessary, states Mr. Merriman in his report, there might be combined with the third stage "an aqueduct extending from the West Branch reservoir to other sources in Dutchess and Columbia counties, thus making available a still further quantity of 180 m.g.d."

Mr. Merriman's summary of the main elements of cost of the project follows:

1.	Rondout reservoir	$26,387,000
2.	Neversink reservoir	7,210,000
3.	East Branch Delaware River reservoir	40,858,000
4.	Tunnel from East Branch to Rondout	21,555,000
5.	Tunnel from Neversink to Rondout	885,000
6.	Tunnel from Rondout reservoir to West Branch reservoir	78,859,000
7.	Constructions on the Croton watershed	8,764,000
8.	Tunnel from West Branch reservoir to Kensico reservoir	34,155,000
9.	Gate-houses and control works at Kensico reservoir	8,494,000
10.	Aqueduct from Kensico reservoir to Hill View reservoir	43,049,000
11.	Aerator and connections at Kensico reservoir	644,000
12.	Gate-house and connections at Hill View reservoir	1,727,000
	Total	$272,587,000

In reviewing the conditions thought to justify going to the Delaware, Mr. Merriman points out that above Tristate Rock, where the three states corner in, the Delaware River has a drainage area of 3,415 sq. miles, of which 2,389 are in New York, 1,016 in Pennsylvania and but 10 in New Jersey. The average daily flow of the river at this point is upwards of 3,600 m.g.d., ranging from 125 to 70,000 m.g.d. "These quantities," states Mr. Merriman, "far exceed any possible use which can be made of them in either or both Pennsylvania and New Jersey." "These unused waters of the Delaware River, of which an average of more than 2,500 m.g.d. originates on the soil of the state of New York, constitute a natural and logical source of supply for the city of New York," especially as "their quality is of the best; they are nearest in point of distance, highest in elevation and they are the most economical for development." Moreover, "the flood waters, which are now absolutely wasted, would, through storage, thus serve not only to regulate the flow of the Delaware itself, but

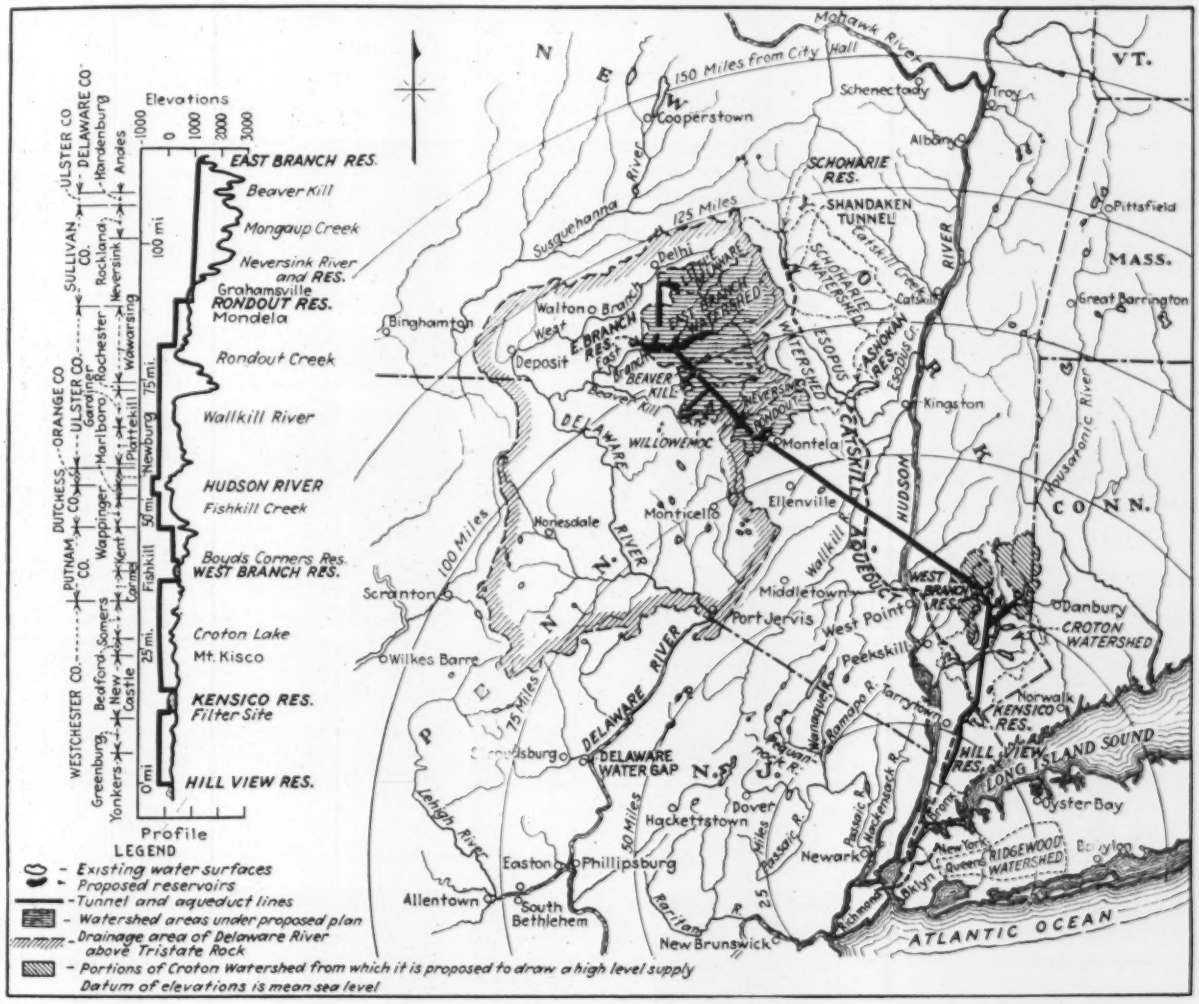
MAXIMUM FLOWS OF DELAWARE RIVER AT TRISTATE ROCK
1905–1923

Computed from U. S. Geological Survey gagings at Port Jervis, N. Y., receiving runoff from 3,073 sq. miles, compared with 3,415 sq. miles above Tristate Rock. The tributary drainage area under the New York plan is 600 square miles.

	Maximum Flow		Minimum Flow		Per Cent Increase
Year	Observed	Probable Under Plan	Observed	Probable Under Plan	Minimum Under Plan
1905	36,510	30,084	667	724	8.5
1906	35,430	29,194	839	865	3.1
1907	44,830	36,940	201	339	68.6
1908	47,130	38,835	125	277	121.6
1909	77,480	63,843	198	337	70.2
1910	48,290	39,791	161	306	90.1
1911	34,720	28,609	314	433	37.9
1912	34,140	28,131	280	405	44.7
1913	60,260	49,659	236	368	56.0
1914	66,490	54,788	210	347	65.2
1915	29,560	24,357	753	794	5.4
1916	40,040	32,993	632	694	9.8
1917	44,180	36,404	492	579	17.7
1918	25,110	20,690	280	406	44.2
1919	18,150	14,956	492	579	17.7
1920	36,520	30,092	789	824	4.4
1921	48,390	39,873	376	484	28.8
1922	37,660	31,032	430	528	22.8
1923	34,640	28,543	370	478	29.2

also to furnish water to the city of New York." After reviewing the negotiations for the tri-state compact, and noting that New York State has twice ratified a compact and that the plan for utilizing the tidewaters of the Delaware now presented is in accordance with the compact of 1927, approved, as stated, by the state of New York, and

(4) That the failure of the legislatures of New Jersey and Pennsylvania to ratify either of the compacts negotiated by their commissioners should not operate to impair the right of the people of the state of New York in a reasonable share of the flood water from the Delaware River or to cause them to expend a sum of money greater by $75,000,000 than would otherwise be necessary in securing that supply of



PLAN AND PROFILE OF PROPOSED NEW WATER SUPPLY FOR NEW YORK CITY

About 600 m.g.d. from flood flows from tributaries of the Delaware River within New York State and 100 m.g.d from Rondout Creek, a tributary of the Hudson River. Aqueduct from new gathering grounds to West Branch reservoir, in Croton drainage system, thence to Kensico and Hill View reservoirs, in Catskill system. Water from three of the higher level reservoirs in Croton system to be diverted to new aqueduct to give delivery at higher head than through Croton aqueduct. The proposed new watersheds adjoin to the west those that feed the present Catskill aqueduct.

after reviewing various decisions of the United States Supreme Court as to the use of interstate waters, Mr. Merriman summarizes the matter as follows:

(1) That our highest court recognizes those principles of fairness and equity on which New York would proceed to utilize a portion of the flood water of the Delaware River.

(2) That no one of the states has a right to all of the Delaware water and that each state has an inalienable right to a portion thereof.

(3) That no better determination of the equities involved is to be had than by the method of negotiation between commissions representing the states; that two commissions have met and have agreed on the basic fundamentals and the results of their agreements must go toward definitely establishing the equities which are at issue. No partisan contention could possibly be of equal force and weight.

water which is vital to their continued growth and prosperity.

(5) The flood waters which New York would take for the purpose of meeting her needs are of neither use, benefit nor value to either Pennsylvania or New Jersey.

The probable effect upon the maximum and minimum flows of the Delaware River at Tristate Rock resulting from diverting the flood flows of the certain tributaries under the proposed plan, taking into account the intention to augment the natural low water flows by discharging stored water down the tributaries in accordance with the terms of the latest proposed tri-state compact, are shown by the accompanying table from Mr. Merriman's report. For abstract of the compact, see *Engineering News-Record*, Jan. 20, 1927, p. 130.

Fourth Article of a Series on
HIGHWAY MANTENANCE

Management of Road Maintenance Equipment

By W. A. Van Duzer
Deputy Engineering Executive, Pennsylvania Department of Highways, Harrisburg, Pa.

SELECTION, purchase, operation and upkeep of equipment are very important functions of a maintenance organization. About twenty per cent of the total highway maintenance expenditures are equipment charges. Therefore, a state which does any considerable amount of maintenance work with its own forces should have a well organized and efficient equipment bureau to provide the equipment that is essential and to keep all of the machinery in the proper condition for turning out good work at reasonable cost.

Selecting and Purchasing Equipment—Many of the highway maintenance operations are seasonal. The greater part of the equipment used for maintaining state roads is owned and operated by the state rather than rented from outside parties. The reasons for this are: (1) the work to be done in a given locality usually demands such a concentration of special type equipment that it could not be obtained locally; (2) if the state could not handle most of the work with its own equipment the rentals charged by outside parties might become excessive; and (3) much of the equipment used by the department is surplus war material obtained gratis from the federal government.

The department should advertise its proposed purchases extensively enough to secure open competition, and the advertising should be accompanied by definite specifications strict enough to discourage the offer of unsatisfactory equipment but broad enough to cover all of the standard and reliable makes. It is not necessary that the specifications should include the details of manufacture, but blank space should be provided for the manufacturer to embody his own detailed specifications.

In purchasing any equipment, first consideration must be given to the serviceability of the machinery for the purpose for which it is being provided—that is, its known ability to stand up and deliver service under road conditions. If the department is buying a type of machinery with which it has not had previous experience, it is necessary to secure reliable information from some other organization that has had the experience. Consideration also must be given to the price, to the adaptability of the machinery for other kinds of work, and to the manufacturer's reliability. It is important that all equipment, so far as possible, be of standardized type; that is, such equipment as has been on the market for several years and in which there is little likelihood of radical change in design. Rollers, traction engines, crushers, concrete mixers, air drills, compressors, and most of the other equipment that a state highway department requires, can be purchased in well-known types from reliable manufacturers.

With any class of equipment standardization is desirable for two reasons: (1) It avoids the necessity of carrying multiple stocks of repair parts, and (2) it avoids the necessity of training repair men and operators to work on various makes. In some cases, particularly when prices are uniform or equivalent, it may not be practicable to standardize upon one particular type or make, but it may be desirable to make the limitation two or three different types or makes.

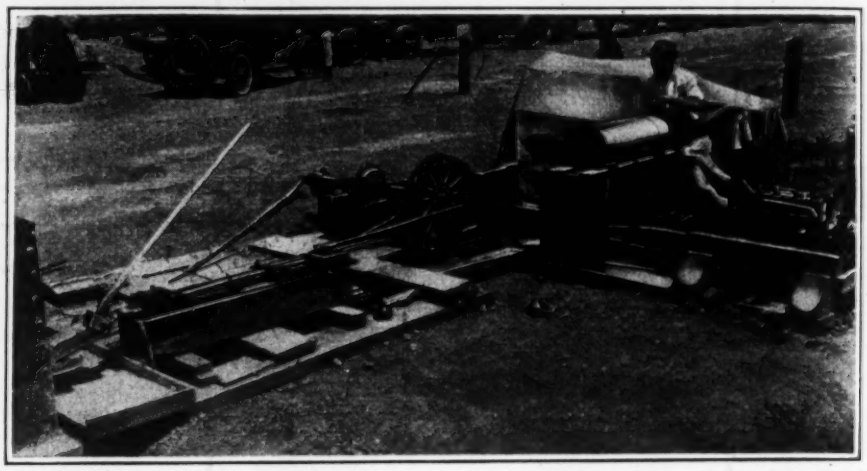


FIG. 1—DEVICE FOR TESTING SHOVELS

TABLE I—LIST OF PENNSYLVANIA DEPARTMENT OF HIGHWAYS NUMBERED EQUIPMENT

Kind of Equipment	Total Number	Kind of Equipment	Total Number
Trucks	760	Buckets (clamshell)	9
Automobiles	391	Cars (dump), steel	163
Motorcycles	251	Carts (dump)	34
Tractors	168	Carts (water)	5
Cranes	9	Forges (blacksmith)	59
Crushers	44	Heaters (surface)	2
Derricks	4	Kettles (asphalt heating)	89
Compressors (air)	54	Machines (linegraph)	58
Drills (steam)	8	Machines (road)	543
Boilers (steam)	27	Plows (road)	118
Engines (traction)	24	Plows (rooter)	67
Guns (cement)	1	Plows (snow)	573
Hoist (steam)	3	Scales (truck suspension)	13
Locomotives	13	Oil distributors	22
Finishing machine (concrete)	5	Scarifiers (road)	16
Concrete mixers	67	Scrapers (road)	33
Unloading outfits	47	Sheds (storage)	74
Conveyors	14	Sprinklers	138
Planers (road)	3	Spreaders (stone)	120
Repair plant (asphalt)	1	Subgraders	5
Pumps (gasoline)	128	Sweepers (street)	56
Pumps (steam)	6	Tanks (storage)	7
Rollers	139	Trailers (trucks)	6
Steam shovel	5	Wagons (dump)	219
Outfits (road repair)	1	Wagons (fire)	2
Box (batch), steel	304	Wagons (water)	6
Batteries (electric firing)	48	Sprayers	1
		Machine (mowing)	54

In purchasing road tools, such as shovels, picks, etc., the specifications may be written closer than those for the larger equipment. Frequently the department can supplement its specifications to advantage by making laboratory tests of the fitness of the tool for its intended use. As an example of a physical testing machine, Fig. 1 shows equipment used in the testing laboratory of the Pennsylvania department of highways for testing shovels, and Fig. 2 shows specimen shovels after they have been tested.

The shovel test consists of a mechanical thrusting of the shovel into a standardized mass of loose aggregate. It is very easy, after a test of this kind has been completed, to make a selection with confidence that the purchased tool will give the best service under actual conditions.

The fitness of picks, bars, etc., can be determined easily by tests. It is important to have reliable methods of testing road equipment and tools just as it is important to have definite specifications under which purchases can be made.

Housing and Caring for Equipment—The department of highways of Pennsylvania has under its jurisdiction more than 12,000 miles of road, over 8,000 miles of which are improved with a bituminous surface treated macadam or higher type. To maintain these highways and keep them in operating condition 365 days in the year necessitates a plant investment of approximately $4,000,000 and over 4,000 individual units, according to the attached list.

To house the equipment properly and to provide shop facilities at points in each maintenance district, there are sheds which are standardized as to dimensions, 40 ft. wide and multiples of 16 ft. in length, the average shed being 40 ft. x 96 ft. The size of the shed, of course, depends upon the amount of equipment to be stored, the number of men required for the winter overhauls, and the number of snow plows operating out of the shed in the winter. These buildings have structural steel frames, metal sides and roof, and are set upon concrete foundations with concrete floors. In one of the sheds in each maintenance district there is a field shop, equipped with

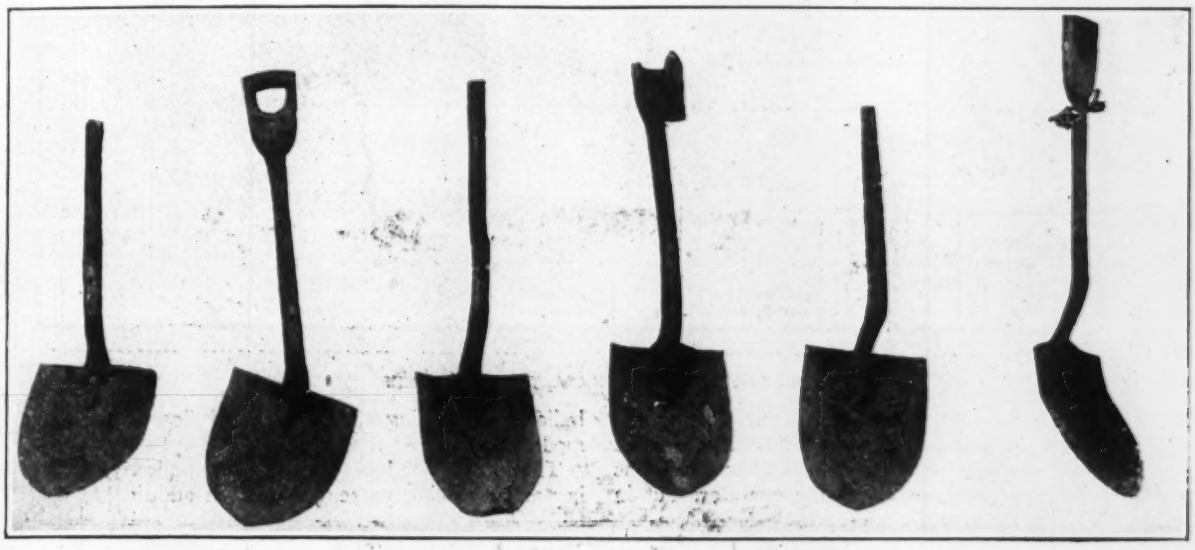


FIG. 2—VIEWS OF SHOVELS AFTER TEST

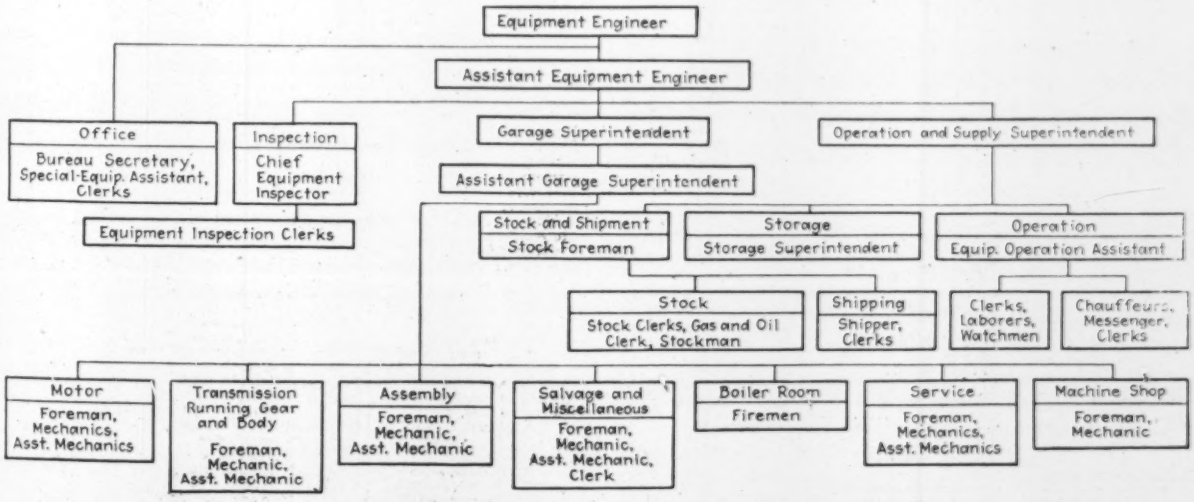


FIG. 3—ORGANIZATION CHART OF EQUIPMENT BUREAU

heaters, electric lights, plumbing fixtures, telephones, gasoline storage tanks and pumps and mechanics hand tools, to do such minor repair work as is necessary to keep the state's maintenance equipment in economical operation. Standard plans are shown in Fig. 4 and a view of the shed is shown in Fig. 5.

In order that each maintenance superintendent may be in constant touch with his equipment, office quarters are provided as shown in the standard plan. During the winter months these offices are open 24 hours a day, as watchmen are maintained to observe weather conditions and sound the snow alarm to get the operators out in case of snow during the night. The organization chart of the equipment bureau is shown in Fig. 3.

Six metal buildings, 60 x 160 ft. are also located at Harrisburg, and are used for dead storage of equipment and parts.

Central Repair Shop—In order to handle major repairs and complete overhauls on equipment, a central repair shop has been established. It is a two-story concrete building containing 42,000 sq.ft. of floor space and is modernly equipped throughout.

The lower floor has facilities for completely overhauling and servicing passenger cars, in addition to equip-

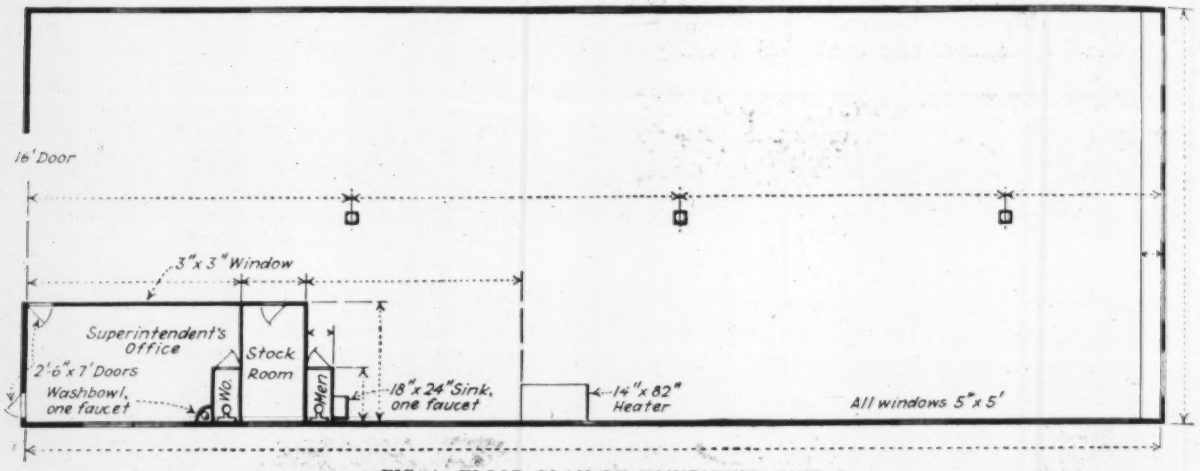


FIG. 4—FLOOR PLAN OF EQUIPMENT SHED

TABLE II—MAINTENANCE EQUIPMENT RENTAL SCHEDULE

Minimum Charge 10 Hours a Day
Equipment with Operator, Fuel and Oil

Items of Equipment	Capacity or Size	Capacity or Size Code	Hourly Rental Rate
Cadillac	Touring	2	$2.20
Cadillac	Sedan	3	2.50
Cadillac	Limousine	4	2.50
Dodge	Touring	2	1.30
Reo	Coupe	7	1.50
Studebaker	Touring	2	1.60
Buick	Touring	2	1.30
Peerless	Touring (6-cyl.)	2	1.60
Peerless	Touring (8-cyl.)	2	1.70
Motor truck	1-ton (Ford)	1	1.00
Motor truck	¾ to 1½-ton (except Ford)	1	1.50
Motor truck	2 to 2½-ton (except Nash Quad)	2	2.00
Motor truck	2-ton Nash Quad	2	3.50
Motor truck	3 to 3½-ton	3	2.30
Motor truck	3-ton F.W.D. on snow removal	3	3.50
Motor truck	3-ton F.W.D. on other work	3	2.30
Motor truck	4 to 4½-ton	4	2.90
Motor truck	5 to 5½ ton	5	3.00
Truck, oil distributor	600 gal. (2 operators)	1	4.00
Truck, oil distributor	800 gal. (2 operators)	3	4.50
Tractor	1 to 4-ton	1 to 4	1.20
Tractor	5-ton (except snow removal)	5	2.50
Tractor	5-ton (on snow removal)	5	3.00
Tractor	10-ton (except snow removal)	9	3.50
Tractor	10-ton (on snow removal)	9	4.00
Crane	1 to 15-ton (2 operators)	1 and 2	2.40
Crane	15-ton or over (2 operators)	3 to 5	2.80
Engine, boiler	0 to 20 hp	1 and 2	1.00
Engine, boiler	20 hp. or over	3	1.50
Engine, traction	18 to 20 hp.	1 and 2	1.10
Engine, traction	20 hp. or over	3	1.20
Engine, hoist	Single-drum	1	1.40
Engine, hoist	Double-drum	2	1.50
Engine, hoist	Triple-drum	3	1.60
Guns, cement		1	5.00
Locomotive	1 to 5-ton	1	1.30
Locomotive	6 ton or over	2 to 4	1.50
Machine, concrete finisher	All	1 and 2	1.30
Mixer, concrete	10 to 14 cu.ft.	2	1.10
Mixer, concrete	15 to 19 cu.ft.	3	1.30
Mixer, concrete	20 to 29 cu.ft.	4 and 5	2.30
Mixer, concrete	30 or over	6	3.30
Plant, asphalt	All (2 operators)	1 and 2	3.30
Plow, snow	Truck-blade	1	.80
Plow, snow	Truck "V"	1	.90
Plow, snow	Tractor "V"	2	1.10
Plow, snow	Tractor, rotary	3	2.00
Rollers, gas or steam	3-ton	3	1.20
Rollers, gas or steam	10-ton without scarifier	2	1.60
Rollers, gas or steam	10-ton with scarifier	2	1.80

Equipment Without Operator
Minimum charge 10 Hours per day

Items of Equipment	Capacity or Size	Capacity or Size Code	Hourly Rental Rate
Shovel, steam	¼ yard (2 operators)	1	$4.00
Dodge	Touring with fuel and oil	2	.90
Ford	Roadster with fuel and oil	1	.40
Ford	Touring with fuel and oil	2	.40
*Ford	Personnel or suburban with fuel and oil	5	.50
Hudson	Roadster with fuel and oil	1	1.20
*Reo	Personnel with fuel and oil	5	.90
*G.M.C.	Ambulance with fuel and oil	6	1.10
* Minimum charge 4 hours per day hauling Personnel, not including operato			
Compressor, air with drills	0 to 100 cu.ft. with fuel and oil	1	.70
Compressor, air with drills	200 cu.ft. (8x8) with fuel and oil	2	1.20
Crusher and bin (Eng. excluded)	6 x 9 to 7½ x 13 jaw	1 to 4	.40
	9 x 15 jaw or over	5 to 9	.80
Derrick	No engine	1	.10
Derrick	2-ton or over	2 to 5	.30
Distributor, chip	1½ cu.yd.	1	.30
Machine, mowing	All	1	.20
Machine, road	2-horse (not including horses)	2	.20
Machine, road	4 to 6-horse (not including horses)	4	.30
Machine, sub-grader	All	1 and 2	.20
Mixer, concrete	5 to 9 cu.ft. with fuel and oil	1	.60
Motorcycle	Solo with fuel and oil	1	.20
Motorcycle	Side car with fuel and oil	2	.20
Planer, road	All	1	.60
Scarifier	4,500 pounds	1	.30
Scarifier	6,000 pounds	2	.40
Sprinkler	1 to 400 gals.	1	.10
Sprinkler	401 to 600 gals.	2 and 3	.20
Sweeper, Street	All	1	.30
Conveyor, Belt	All	1 to 9	.60
Office, supt. located in department shed or house (charge 10 hrs. per day)			.10

Equipment for Which No Rental Will Be Charged

Batteries	Plow, road
Box, batch	Plow, rooter
Bucket, clamshell	Pump, gas and steam
Cars, dump	Scale
Cars, hand	Scraper, road
Cars, R.R. flat	Sprayer
Carts, dump	Stone spreader attachment
Carts, water	Tank, storage
Drill, steam	Tool boxes
Forge	Trailers, truck
Heater, surface	Wagon, dump
Kettle, asphalt	Wagon, fire
Marker, traffic line	Wagon, water

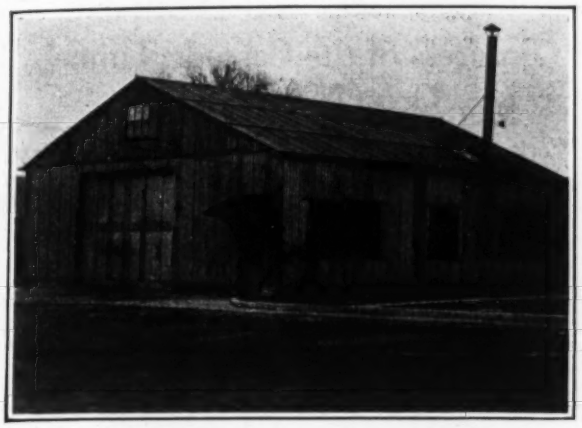


FIG. 5—VIEW OF EQUIPMENT SHED

ment for spray painting, brush painting, battery charging, magneto repairing, upholstering, top building and car washing. Fig. 6 is an interior view.

The upper floor handles overhauling and major repairs on all equipment other than passenger cars. Since the majority of this work is on trucks, the space is laid out for repairing motor vehicles on a production basis. In order to operate efficiently the work on this floor is divided among the following groups: Motor transmission and differential, chassis, radiator, dynamometer, blacksmith, machine shop and salvage.

The shop organization is of the line type, in which each man is directly responsible to his supervisor for his operation or division of the work. Data are obtained on the time which a certain operation should require. A workman's classification, upon which his hourly rate depends, is determined by the quality and amount of work turned out, together with his length of service. Strict attention is paid to cleanliness throughout the building. Features of the shop procedure include: (1) A unit replacement system which materially reduced the time necessary for an overhaul. This is done by keeping overhauled units on hand ready to replace defective units on vehicles brought in for overhaul. (2) A dynamometer, Fig. 7, which is used for running-in and testing rebuilt engines. Any defects in an engine show up on the test block and preclude the possibility of an engine failing after it has been assembled into the vehicle. (3) An automatic air compressor which supplies air for pumping tires, cleaning, spray painting, and operating pneumatic tools. (4) A cleaning tank where all parts are boiled in a soda solution for removing grease and scale. Thus the expense and fire hazard of using gasoline as a cleanser are avoided. (5) Part of both floors is securely partitioned off and is used for stocking parts for supplying not only the equipment being overhauled, but all equipment throughout the state. Twenty-four-hour service is maintained at all times on all the 16,000 parts carried. A shortage of any part is almost unknown due to the perpetual inventory system used for stock records.

Equipment Control—Traveling inspectors make periodical inspections of all equipment, making report on a standard form. On a similar form the maintenance superintendent reports completion of the recommended repairs.

A registration section in the Harrisburg shops keeps a record of the status of department-owned equipment. This information covers the kind, type, date purchased, price paid, serviceability, unserviceability, location, etc., and also the yearly depreciation and the net book value.

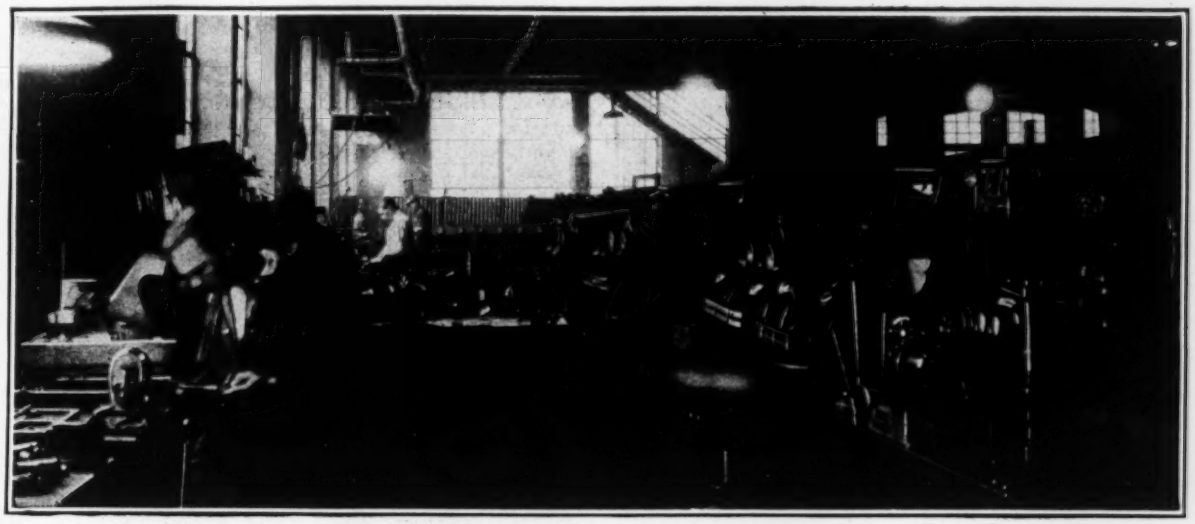


FIG. 6—INTERIOR VIEW CENTRAL MACHINE SHOP

All major department equipment is numbered with a seven figure serial number, the first three figures designating the department number in the order of its purchase, the fourth figure representing the size or capacity and the last three figures indicating make and kind of equipment. This number is stenciled or stamped upon all equipment and all charges incident to the maintenance and operation during the life of the equipment is charged to this number.

In the system of cost records, the total service life of any piece of equipment is not a definite fixed quantity but is dependent upon various conditions. However, from the experience of the past few years it is possible to set up a definite life for each piece of equipment and a certain percentage is charged off each year.

Maintenance Equipment Charged to the Work—The equipment in use is charged on a rental basis to the operation for which it is used. In this way it is possible to

determine accurately the cost of work done by department forces for a comparison with the cost of work by contract, for example, and at the same time the rental rates necessary to sustain the equipment bureau and the operation of the equipment bureau within the funds set apart furnish a reliable measure of efficiency. Minor equipment and hand tools are classed as expendible and replaceable upon condemnation or turning in of unserviceables. They are not charged on a rental basis but as a fixed per cent on each maintenance payroll and department force project.

The rental rates were established to cover operating

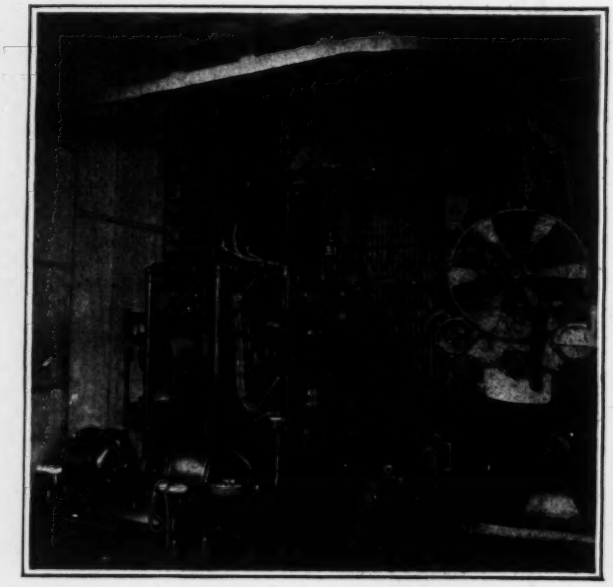


FIG. 7—DYNAMOMETER FOR TESTING AUTOMOBILE ENGINES

costs, including drivers' wages, gas, oil, tires and incidentals, cost of repairing and overhaul, including costs of operating the repair shops, and sufficient depreciation to set up a fund for the replacement of the equipment when it should have become unserviceable. The rental rates for major equipment are shown in Table II. Equipment payrolls are submitted on a form and a performance record card is maintained for each piece of major equipment owned by the department.

The purchase, maintenance and operation of maintenance equipment deserve the same high-class executives as any other unit of the highway field. Rigid specifications, careful and intelligent purchase, examination of all operators, periodic inspections facilitate the economical handling of this branch of highway industry.

[*The next article will be "Determining Snow Removal Requirements," by V. R. Burton, Engineer, Research and Statistics, Michigan.*—EDITOR.]

Alexandria Has Extensive Paving Plan

Street paving in Alexandria, Egypt, the contracts for which will amount to approximately $1,000,000, is planned, as noted in advices from Ralph B. Curren, assistant trade commissioner at Alexandria, to the U. S. Department of Commerce. Residence, business, warehouse and dock districts will be included in the program, and the paving will include granite block, bituminous asphalt and macadam. Contract letting, mostly completed, has been to firms represented in Egypt.

Progress of the Cascade Tunnel, Great Northern Ry

Work on 8-Mile Rocky Mountain Tunnel Ahead of Schedule—Review of Methods and Advance to June, 1927

IN DRIVING the new Cascade Tunnel of the Great Northern Ry., in Washington, progress up to June 1 was as follows: (1) Pioneer tunnel from west end, at Scenic, 11,681 ft.; (2) center heading of main tunnel from east end, at Berne, to Mill Creek shaft (completed), 12,733 ft.; (3) pioneer tunnel driven west from shaft, 5,080 ft.; total, 29,414 ft. or 5.59 miles. There remained then 11,610 ft. to be penetrated between the most advanced faces. In the first and third of the above items, and in the enlargement from the east portal, the work was 4,934 ft. and 299 days ahead of the scheduled program. In the enlargements from the west portal and westward from the shaft, the work was 857 ft. and 30 days behind schedule. Taking the project as a whole, the progress was 137 days ahead of the schedule.

It may be explained that the method of construction at the Cascade Tunnel is peculiar in that while a pioneer tunnel is employed, it extends only from the west end for about 75 per cent of the length of the main or railway tunnel. At the east end it terminates in a crosscut entering a construction shaft. The center heading of the main tunnel from the east portal to the shaft, 2.41 miles, was holed through on March 4 with an error of only 2¾

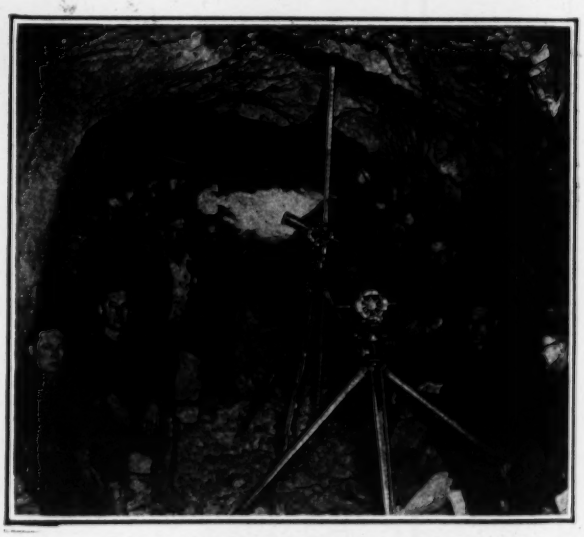


FIG. 1—EAST HEADING HOLED THROUGH TO SHAFT March 4, 1927. Engineers grouped at the break.

in. in line. The above construction plan and the general situation up to June 1 are shown in the accompanying drawing.

Pioneer Tunnel—Previous rapid progress in the west pioneer tunnel was checked by a faulty or badly shattered zone of granite carrying water under pressure in all the seams, but the maximum discharge of more than 10,000 g.p.m. decreased to 6,500 g.p.m. By May 20, this water-bearing zone appeared to have been passed, dry ground with about 30 per cent of quartz diorite being then encountered. Although the former seamy condition was not considered in itself dangerous, the

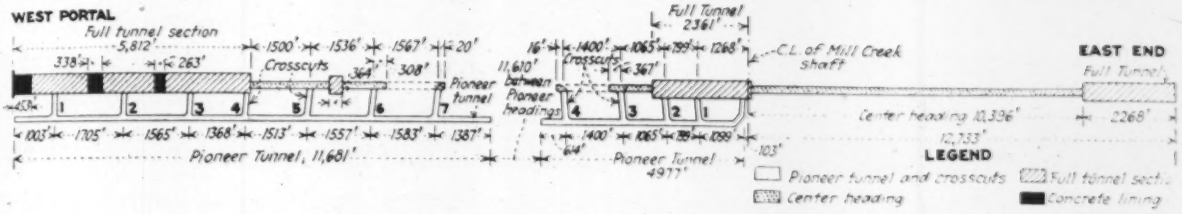


FIG. 2—PROGRESS PLAN OF CASCADE TUNNEL; GREAT NORTHERN RY.

fact that a slide might have trapped men at the face made it necessary to timber areas that otherwise might have been passed as safe. With the completion of crosscut 8, immediately east of the water-bearing zone, tunnel equipment can be handled without passing through this wet portion of the work.

The pioneer tunnel working west from the Mill Creek shaft was mainly in quartz diorite. But this material changed frequently from short grained rock, that broke easily, to a heavy blocky material containing streaks of a substance like graphite. This rock was troublesome, as it had a tendency to break to the seams, thus increasing the overbreak, while it air-slaked to such an extent as to require frequent and careful scaling as a protection for the men.

Enlargement—In the enlargement of the headings to full tunnel section, during the month of May the work from the east portal at Berne was advanced 1,008 ft. (with 40 ft. per day for five consecutive days), and that

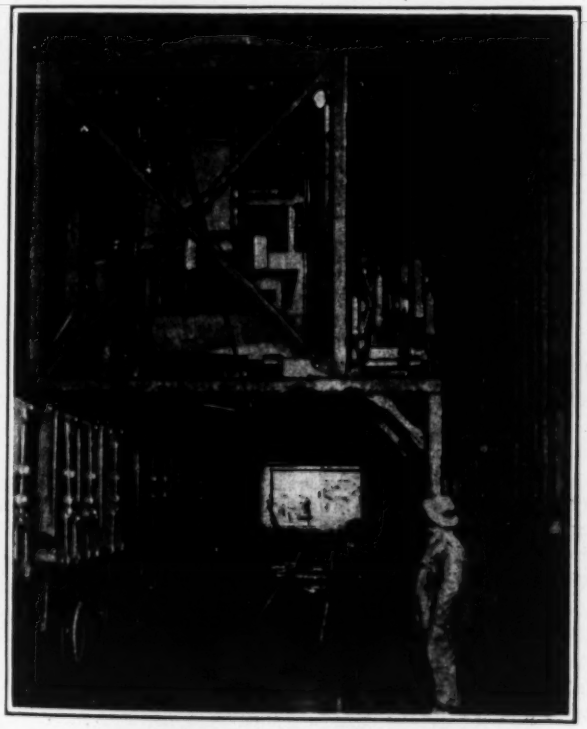


FIG. 3—CONCRETE LINING PLANT; WEST PORTAL

from the shaft was advanced 696 ft. The former was favored with good ground conditions, both the granite and quartz diorite being drilled and blasted easily. Ventilation was improved by placing a fan near the Mill Creek shaft to blow a current of air east toward the portal. Enlargement from the shaft was also favorable, as improved ground conditions permitted a change from a top heading and bench to a center heading. As the material excavated here has to be taken up the shaft, considerable experimenting was necessary in the drilling and shooting in order to break the material sufficiently small to pass through the loading pockets from which the hoist buckets are loaded.

Enlargement at the west end has been delayed by unfavorable ground. A sceond enlargement was therefore started April 20 between crosscuts 5 and 6, and made an advance of a little more than 300 ft. The work from the portal was in a coarse blocky granite until April 8, at station 354, at which point the material changed to quartz diorite. The latter is drilled easier and generally breaks up smaller, thus reducing the overbreak, but it has the disadvantage of slaking badly in some areas, necessitating frequent scaling and consequent loss of time. A light coat of gunite applied by machine in these troublesome areas has proved satisfactory in reducing the slaking and falling of rock. Very poor ground was encountered at station 343, for while the center heading seemed favorable, pressure developed when the full section was opened up, making it necessary to put in timbering.

CASCADE TUNNEL: PROGRESS TO JUNE, 1927

	Ft.
Scenic, West End:	
Pioneer tunnel	11,681
Main tunnel, center heading	7,958
Main tunnel, enlargement	5,812
Berne, East End:	
Main tunnel, center heading	9,535
Main tunnel, enlargement	2,173
Mill Creek:	
Pioneer tunnel	4,977
Main tunnel, center heading, East	3,135
Main tunnel, center heading, West	2,267
Main tunnel, enlargement	2,361

Concrete Lining—Placing concrete in the full-section railroad tunnel was begun April 27 at the west portal and had advanced 1,054 ft. by June 1. It is expected that this work will proceed at the rate of about 1,100 ft. per month, the concrete being placed by the compressed-air process. At the east end, the concreting plant was being installed, and it was planned to have the steel forms and travelers erected in time to begin placing the lining in July.

Working Force—Exclusive of headquarters and kitchen crews the force numbered 1,270 men, distributed as follows: At Scenic, west end, 598 men, of whom 93 per cent were on underground work; at Mill Creek, 426 men, 88 per cent underground; at Berne, east end, 246 men, 80 per cent underground. Labor conditions were satisfactory, the turnover during the March-May quarter being only about 2 per cent.

Engineers and Contractors—This 8-mile tunnel is being driven by A. Guthrie & Co., Inc., St. Paul, Minn., with W. E. Conroy as general superintendent. The work is under the direction of J. R. W. Davis, chief engineer, Great Northern Ry., and in direct charge of Frederick Mears, assistant chief engineer.

River Control in the Palo Verde Valley

An Effective and Economical Spur Dike System Developed by Irrigation District on Lower Colorado River

By Spencer E. Webb
Caldwell & Richards, Civil Engineers, Los Angeles, Calif.

EFFECTIVE and economical channel correction methods have been carried on for a number of years on the Colorado River in the Palo Verde valley, in the extreme southeastern part of Riverside County, Calif.

The Colorado River flows with a fall of about 1½ ft. per mile, over an alluvial bed in a narrow valley bounded on either side by a mesa about 100 ft. high. Rapid fluctuations in the flow resulted in the valley lands being continually flooded, until the Palo Verde Irrigation District constructed a 34-mile earth levee which protects

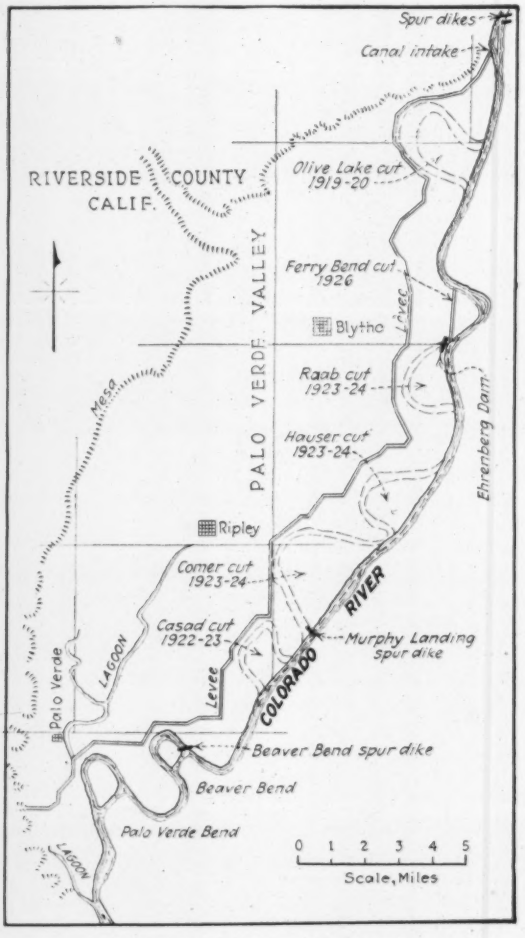


FIG. 1—PALO VERDE VALLEY
Showing levee location and course of Colorado River with cutoffs and spur dikes.

77,000 acres out of the 90,000 acres comprising the district. The river discharge varies from 3,000 to as high as 190,000 sec.-ft. during flood, when the banks erode and the stream bed scours rapidly. The mean annual runoff is about 16,000,000 acre-ft. and the annual silt burden is immense, amounting to 80,000 acre-ft. A large amount of drift is also carried down by the river.

The levee constructed by the irrigation district is of sufficient height to prevent the river from overflowing on the cultivated lands. Control methods have kept the channel of the river at a sufficient distance from the levee to prevent undermining. Several years ago a straight channel was provided for in the river on a line as far from the levee as possible, by making a series of cuts having bottom widths from 40 to 50 ft. and 6 to 11 ft. in depth. During an attempt to divert the river into one of these cuts in 1924, in which a dam was constructed across the old river channel, a method was

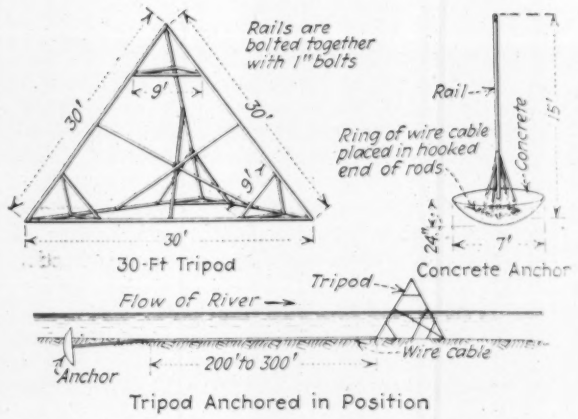


FIG. 2—DETAIL SKETCHES OF TRIPOD AND ANCHOR

devised making use of steel tripods to form dams and spur dikes, which locally are called "jetties."

These tripods are equilateral pyramids constructed from scrap railroad rails 30 ft. long, bolted together with 1-in. bolts. A triangle of 9-ft. rails is used near each apex for bracing; and three additional braces, reaching from the middle point of each base rail to the middle point of the opposite slope rail, are used. In constructing a spur dike, a line of tripods is set out from the bank on about 35-ft. centers as required. The effect of the spur dike is greatly increased by the drift pack which invariably collects on the upstream side. During flood periods a spur dike will cause a sand bar to be built downstream for as far as a half-mile.

Due to the force of the current on the drift pack, it is necessary to anchor the tripods securely. Wherever possible they are held fast by 1-in. cables tied to deadmen set in the bank about 300 or 400 ft. upstream. In cases when it is impossible to anchor to deadmen, a specially constructed anchor is used, consisting of a concrete head with a steel rail stem set into it. The anchor is cast by scooping out a saucer-shaped hole in the ground and placing the steel rail stem in a vertical position, together with the necessary tie-rods, and pouring the hole full of concrete. An anchor with 200 or 300 ft. of cable and a tripod make up one unit of the spur dike. When placed in the river the anchor quickly settles in the bed and almost immediately provides a secure anchorage.

In 1924 the Ehrenberg dam was built for the purpose of diverting the river into the Raab cut. This was a very difficult job because of the unfavorable direction of the river at the head of the cut and also because the work had to be completed during a flood season. Steel tripods were used five deep over part of this dam. Each

tripod readily collected a large amount of drift which settled and formed a dam that successfully withstood the Colorado River flow, even during flood season.

At the extreme northeast end of the valley a temporary diversion weir was constructed for the Palo Verde Irrigation District in 1924. This weir was constructed during low water when the river was carrying no drift, so that all of the drift material had to be placed there. Shortly after the weir was completed an increase in flow in the river from 3,000 to 11,000 sec.-ft. caused a failure in the weir, due possibly to the fact that the spillway did not have adequate capacity. Another temporary weir was constructed in 1925, but no shortage of water occurred during this season.

During the past winter spur dikes have been built at

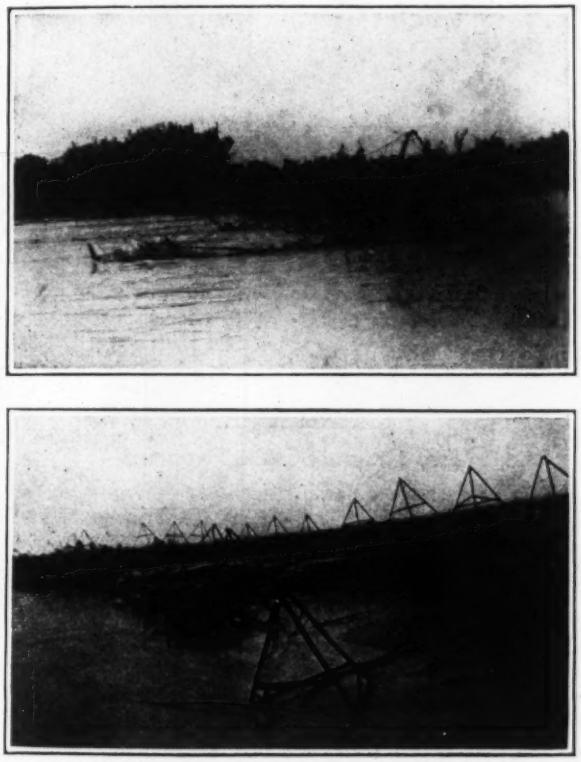


FIG. 3—EHRENBERG DAM
Upper view taken during construction and lower view during early part of 1927.

three locations. The first was a secondary dike built on the Arizona bank about a half-mile above the diversion weir; its purpose was to keep the river in a proper location above the weir. It consists of 11 tripods anchored by four 1-in. cables to a first dike, located at this point on account of the extreme heavy river bombardment during times of flood. Construction was handled entirely from the shore at a cost of $1,316.

During the flood seasons of 1925 and 1926 a peculiar condition developed at the mouth of Comer cut, near the old Murphy ferry. Instead of the river continuing its usual course straight ahead, practically the entire discharge swung toward the west and a large volume escaped through the old Casad bend channel where most of the silt was deposited. From the old channel a large flow of practically clear water continued southward near the levee and returned to the channel along the Beaver bend. No erosion occurred, however, as the ground on the river side of the levee had never been disturbed. So great was the diversion at this point in June, 1926, that it was felt that the entire river might leave its course to the south and develop a new channel which would be dangerously near the levee. After the flood had passed,

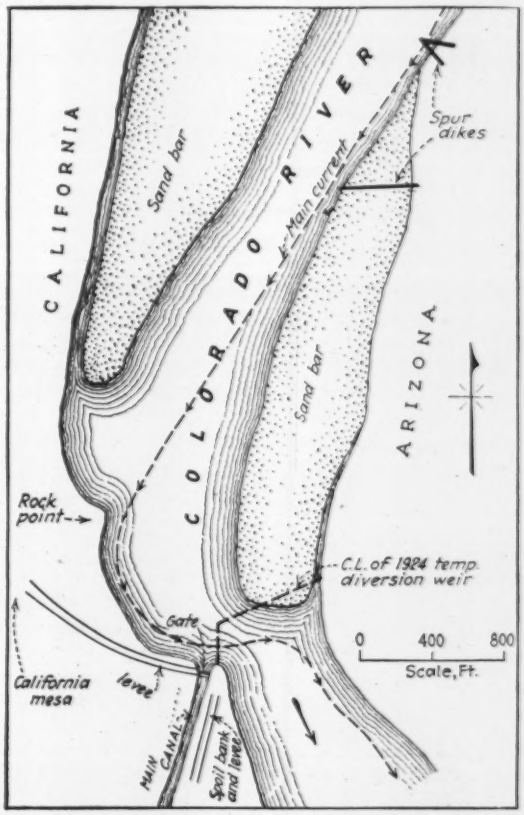


FIG. 4—RIVER CHANNEL IN VICINITY OF CANAL INTAKE

the river soon resumed its straight course again. To prevent recurrence of the diversion a spur dike was built on the west side of the river a short distance downstream from the mouth of the Comer cut. A brush mat was built out into the shallow water as far as the dike was to extend to provide a roadway. This mat no doubt was of considerable value while the dike was being subjected to floods. Four 30-ft. tripods were erected on the stream end of the dike and six 15-ft. tripods extended back a short distance on the flood bank. Anchorage was secured by four 1-in. cables tied to deadmen on the bank and upstream about 400 ft. A cable was strung along the downstream side of the dike to help retain drift. Six 15-ft. tripods, spaced about 50 ft. apart and tied together with ½-in. cables, were placed on the downstream side of the dike with the idea of eliminating any backlash that might occur. A few weeks after the job was completed, a two-day flood carrying a discharge of 65,000 sec.-ft. occurred, resulting in a low sand bar several hundred feet wide and more than a half-mile long being formed directly below the dike. In March, 1927, a high sand bar had been formed directly below the dike, and the main river channel had branched westward. After the flood season of 1927, it is planned to construct a second spur dike about one-quarter of a mile downstream from the present dike.

A third spur dike was completed in January, 1927, at the Beaver Bend channel. This bend has developed

since 1912, and in June, 1926, it had cut within a quarter-mile of the levee. The summer discharge then fell to 3,500 sec.-ft. and cut a small channel through the low sand bar left across the high water channel. It was then decided to dam the abandoned channel so as to turn the flow westward and away from the levee. Thirty-five 20-ft. tripods were placed across the channel spaced 22 ft. on centers, making a line about 750 ft. long. The usual cable fence was strung on the downstream side, and from every alternate tripod seven 10-ft. tripods were set in a line at 45 deg. downstream. Six ½-in. cables were strung along the 10-ft. tripods and three 1-in. cables were run through them parallel with the 20-ft. tripods. These cables tied the tripods together and prevented their displacement. This artificially-

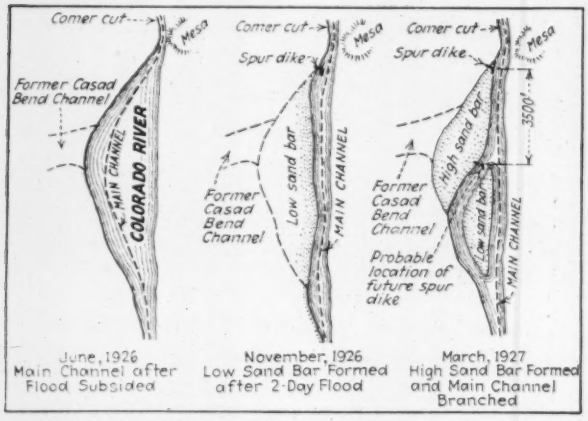


FIG. 5—RIVER CHANNEL MOVEMENT AT MOUTH OF COMER CUT

reated bank across the June channel was to turn the low and relocate the entire bend. Just after finishing placing the structure, the river discharge increased from

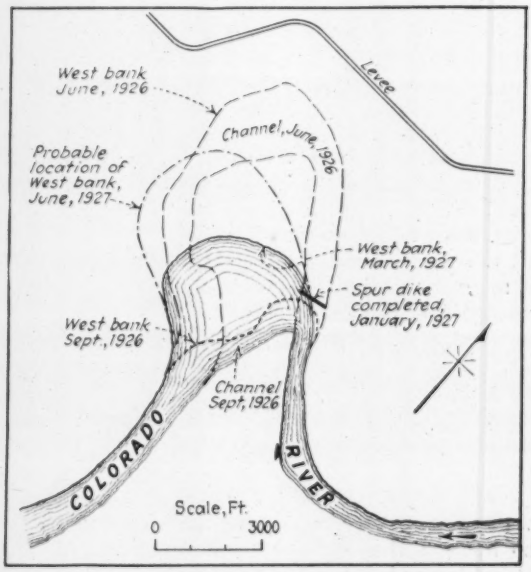


FIG. 6—RIVER CHANNEL MOVEMENT AT BEAVER BEND

),000 to 60,000 sec.-ft. in about 5 hr. The flow rushed through before any drift had formed a bank and caused the west half of the structure to settle rapidly. At the end of two days the tops of the 20-ft. tripods were just above the water and the June channel was completely filled with a sand bar. It is expected that the bend will lengthen considerably during the 1927 summer flood season. No more work is being done on this structure for the present. The cost of the entire job, which took 60 days to complete, was $5,629.50.

The steel tripod unit, from which these structures were formed, was developed by Floyd Brown, who for several years was manager of the Palo Verde Irrigation District, the Palo Verde Mutual Water Co., and the

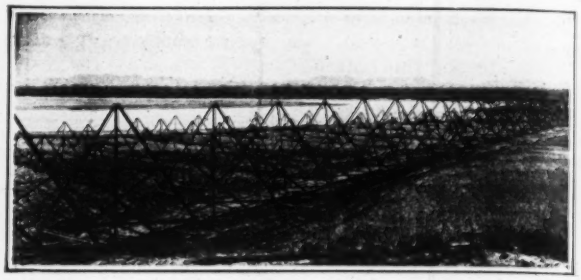


FIG. 7—BEAVER BEND SPUR DIKE UPON COMPLETION

Palo Verde Joint Levee District. He was assisted by M. E. Christensen, river crew foreman for the past five years. H. C. Neuffer, at one time engineer for the Levee District, devised the first concrete anchors used. The writer has been resident engineer on the project for the past two years, representing Caldwell & Richards, civil engineers, Los Angeles, Calif.

Two Fatigue Studies Reported

Two new series of endurance strength tests are reported by the Illinois Engineering Experiment Station in Bulletins 40 and 41, just issued. The former gives the study of fatigue of cast iron recently presented before the American Society for Testing Materials (reproduced in abstract in *Engineering News-Record*, July 21, p. 94), but in more extended form. The second, entitled "A Study of Fatigue Cracks in Car Axles," led to the conclusion that by various simple methods (examination by low power microscope, examination after coating the surface with gasoline and then subjecting the part to reversed bending stress, or else, after coating it with oil and wiping off the oil, coating it with whiting and striking the part a sharp blow) it is possible to detect a fatigue crack in its early stages. Specimens in which fatigue cracks had been produced by cycles of stress of an intensity 20 per cent above the original fatigue limit were still able to resist up to 100,000,000 cycles of stress before fracture. Fewer cycles of stress were required to produce fracture when the stress was high than when it was only slightly above the endurance limit. The seriousness of a crack of minimum detectable size was found to be greater in a small specimen than in a large specimen. Specimens in which a fatigue crack had been started showed a continuing spread of the crack, to failure under subsequent cycles of stress of an intensity of 64 per cent of the original endurance limit, whereas when the subsequent stress was 50 per cent of the original endurance limit the crack did not spread. It is concluded that periodical shop inspection by means of the oil-and-whiting test will make it possible to detect most fatigue cracks in car axles before they lead to service failure.

Schenectady Sewage Chlorination Studies, 1926-27

Plant-Scale Application of Chlorine to Imhoff Tanks and Trickling Filters Results in Improvement in Operation and Partial Control of Psychoda

By Morris M. Cohn
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Schenectady, N. Y.

THE CHLORINATION studies made during the summer of 1925 on the trickling filters of the sewage-works of Schenectady, N. Y., as reported in *Engineering News-Record*, June 10, 1926, p. 943, were followed by more intensive plant-scale studies on both the Imhoff tanks and trickling filters, as detailed in this article.

The studies of 1925 were confined to an acre of trickling filters and led to findings on the effect of chlorination of sewage prior to filtration on odors, fly production and physical conditions of the filter beds. Filter odors were reduced and there appeared to be a reduction in fly life after the removal of the surface film from the filter media by the chlorinated sewage. The physical condition of the beds and distribution system was greatly improved.

Studies of 1926-7—During May and June, 1926, the economy of chlorination of raw sewage before tank treatment compared with chlorination of tank effluent prior to filtration, was studied. Observations were made on odor improvement and on physical improvement of the treated tank. Valuable data were obtained indicating the effect of chlorination on the bacterial life in the treated sewage and tank effluent. The findings of this preliminary study warranted the chlorination of a complete battery of Imhoff tanks during the summer of 1926, and the accumulation of comparative data from the treated battery against another battery used for control purposes and therefore untreated. This study was made to test the possibility of odor control at low chlorination rates.

The apparent reduction in flies produced by chlorination of the one acre of filters during 1925 led to the periodic chlorination of all of the six filter units as a regular operation practice during the summer of 1926 to determine the value of this process of fly control. This work is being continued in 1927. During the winter of 1926-27, the raw sewage entering one Imhoff tank unit was again chlorinated, this time to determine the effect of chlorination of raw sewage treated by an Imhoff tank on the sludge digestion efficiency of the treated unit during the period of winter sludge storage. A split chlorination study was made in 1926 to learn whether a saving could be effected in the quantity of chlorine required to produce a residual chlorine in the sewage entering the filters by adding a portion of the chlorine to the raw sewage and the balance after the sewage had received tank treatment.

Economy of Prechlorination—During the spring of 1925, the sewage entering Imhoff tank No. 6 was chlorinated at a rate increasing from 4 to over 20 p.p.m. to ascertain the effect of this treatment on tank odors and on the tank effluent. Application of chlorine at a rate of but 4 p.p.m. gave distinct residual chlorine throughout the tank length, and in the effluent on several occasions, and rates of from 6 to 8 p.p.m. gave practically constant residuals. It was found impossible to obtain a trace of residual chlorine in tank *effluent* shortly after it had been dosed at any rate less than 8 p.p.m. Prechlorination for odor control was continued during the summer of 1925, but on a complete battery of tanks. Parallel tests run on raw sewage and tank effluent during these summer months indicated that the chlorine demands of these two liquids were practically the same. Prechlorination at Schenectady is therefore more economical in the early spring because of the overloaded condition of the Imhoff tanks and the tendency of the tank effluent to become slightly septic from the solids belching up from the overloaded tank hoppers. With the improvement in tank operation due to the removal of sludge, the chlorine requirement of the tank effluent approximates that of raw sewage and the economy of prechlorination is not marked. At Schenectady the curve of tank efficiency in removal of suspended solids closely follows the slope of the curve of solids accumulation in the sludge and scum compartments.

Odor Control and Hydrogen Sulphide Reduction—The first indication of odor improvement as a result of prechlorination of raw sewage came during the spring of 1925 when but one Imhoff tank was being chlorinated. A marked difference was then noted between the odor of the effluent of the treated tank and the liquor leaving a tank used for control purposes. The former had a clean, pleasant odor even at such rates of application as 4 to 6 p.p.m., and this excellent characteristic became more distinct with each increase in rate. At higher rates, free chlorine could clearly be detected. The untreated effluent had the characteristic semi-septic odor and hydrogen sulphide was present. At times the chlor-amine odor from tank No. 6 could be detected over the entire battery of tanks. The difference in the color of the treated and untreated tanks was most marked. The treated tank had a light gray color during the early morning that was supplanted by a leathery brown color during the hours of high flow. The untreated tank had the usual gray to dark gray color at all times. The sewage in the treated tank contained much flocculent solids and resembled that of an activated-sludge tank.

The success of this test run led to a more thorough study during the same summer on a complete battery of Imhoff tanks. To obtain comparative data, the other battery of tanks was left untreated during most of the run. Chlorine was applied at a rate of about 150 lb. per 24 hr., the average flow through the treated battery of tanks being 3 m.g.d. No attempt was made to vary the rate of chlorine flow as the sewage flow fluctuated. The average rate of chlorine application was 6 p.p.m. and the rate during the hours of heavy flow was but slightly better than 4 p.p.m. Hydrogen sulphide determinations

were made upon the composites of hourly samples taken from 8 a.m. to 3 p.m. of treated and untreated effluents. Residual chlorine determinations failed to disclose excess chlorine at any point in the tanks or in the effluent at any time. The same distinct improvement in odor indicated by the preliminary study was noted.

The treated battery effluent always had the chloro-substitution odor that was accentuated on agitation by the weirs and by the steps of the siphonic chamber, while the untreated effluent gave even more marked evidences of hydrogen sulphide on being agitated. The prechlorinated liquid smelled distinctly fresh and pleasant when sprayed onto the beds, despite the fact that but 4 p.p.m. of chlorine had been applied to the raw sewage and that there was no residual chlorine in the sewage even after it had just entered the tank.

Extent of Action and Economy—Parallel tests made on raw sewage prior to chlorination and on prechlorinated tank effluent indicated that hydrogen sulphide was greatly reduced by the application of but 4 p.p.m. of chlorine. Hydrogen sulphide was never absent in the treated tank effluent, despite the fact that no septic odors from this liquor were ever noted. This tends to indicate that control of odor from tanks and filters does not necessarily mean complete elimination of hydrogen sulphide. The extent of chlorination, and in direct connection the extent of hydrogen sulphide elimination, will depend upon the requirements of each sewage-works. A report presented by the Division of Sanitation of the New York State Department of Health, whose representative inspected the Schenectady treatment plant during the beginning of the odor studies and made suggestions on the prosecution of the work, states: "Results indicate that the application of 6 p.p.m. of chlorine to the raw sewage effectively reduced the concentration of hydrogen sulphide and prevented the production of odors when the settled sewage was applied to the sprinkling filters. The very slight septic odor of the effluent of the tanks receiving chlorinated sewage did not produce a nuisance even when in the immediate vicinity of the nozzles receiving this material."

Studies made elsewhere indicate that fresh sewage can be chlorinated more economically than can sewage after it has passed through a trunk sewer to the treatment works. In view of these findings, it is planned to chlorinate about 65 per cent of the sewage tributary to the Schenectady plant, at a pumping station located about two miles above the works. Studies will be made to ascertain the economy and effectiveness of this plan.

Bio-chemical Oxygen Demand Reduction—An encouraging phase of prechlorination of raw sewage prior to settling was found to be the reduction in bio-chemical oxygen demand of the tank effluent resulting from the treatment. B.o.d. determinations were made on the 8 a.m. and 3 p.m. composites of the effluents from the treated and untreated batteries. The samples from the treated tanks were re-seeded with 1 c.c. of sewage and blanks deducted to give the true b.o.d. results. Incubation was for from 2 to 4 days as laboratory work permitted, short periods being used to assure rapid determinations of the effect of prechlorination. No attempts were made to ascertain the b.o.d. differences after longer incubation.

Preliminary studies made on the normal untreated effluents of the two batteries of tanks later used in the chlorination work, indicated that the normal b.o.d. of these liquors was practically equal. This is interesting in view of the fact that the normal influent and effluent of the battery later chlorinated always ran lower in suspended solids by weight than did the liquor entering and leaving the battery used for control purposes. The first-named effluent was slightly more septic and contained much more light, colloidal solids than did the other. This septic and colloidal condition increased the b.o.d. of this effluent.

The parallel tests run during the prechlorination period indicated that the prechlorinated effluent usually ran lower in b.o.d. than the untreated effluent. On about 18 days parallel samples of the two effluents were tested. Results indicate that the b.o.d. of the effluent from the prechlorinated battery was 27 per cent lower than the oxygen demand of the liquor leaving the untreated tanks. In view of the similarity of the two normal effluents, the difference appears to have been caused by prechlorination of the raw sewage.

Effects of Prechlorination on Sludge Digestion—One of the major questions that arose during prechlorination of raw sewage was the possible deleterious effect of the gas treatment on the anaerobic digestion agencies in the tanks and the consequent effect on sludge conditioning. In the spring of 1926, no effect on this phase of tank operation was observed, and the results of several simple investigations were indeterminate.

No attempts were made to observe differences in sludge digestion in the two parallel batteries of tanks during the summer of 1926 since the sludges produced by these units were never strictly comparable during normal operation. Nevertheless, excellent sludge was obtained at all times from the battery of treated tanks.

The winter study of 1926-27 was made to learn the exact effect of chlorination on sludge digestion during the winter period of sludge storage. Observations made on sludge drawn from the treated tank and from a tank that was untreated and that was subject to comparable flow and loading conditions indicated that no deleterious effect resulted from tank chlorination. Of all sludge drawn from these two tanks, the odor has been similarly slight, the consistency of the treated sludge has been somewhat heavier, the color somewhat darker, and the organic matter content slightly lower.

A most important phase of this chlorination study was the capturing in buckets immersed in the sedimentation compartments of 24-hr. composite samples of unchlorinated and of chlorinated fresh solids for Prof. Gordon M. Fair of the Harvard Engineering School. These samples were sent to his laboratory for use in studies on sludge digestion. The results from Professor Fair's work, which it is expected will be published later in detail, indicate that chlorinated solids digest more rapidly than unchlorinated solids, and that methane gas production at the end of two to three weeks of digestion was practically twice as great from the chlorinated solids as from the unchlorinated. The pH value of the digesting sludges remained consistently higher and likewise increased at a more rapid rate in the case of the chlorinated solids.

Other Results of Prechlorination—Prechlorination of raw sewage entering the Imhoff tanks had no effect on filter operation outside of the improvement in odors emanating from the spray.

Bacterial studies on the tanks made during the heavy chlorination of May and June, 1926, and the following

summer, through the courtesy of the Division of Laboratory and Research of the New York State Department of Health, indicate that marked reductions in bacterial population of an Imhoff tank effluent can be effected by chlorination of the raw influent. It appears that residual chlorine is necessary at the first one-third point of the tank length to assure satisfactory bacterial removal.

Economy of Split Chlorination—No saving in the amount of chlorine necessary to produce a residual chlorine at the filter nozzles resulted from adding a small portion of chlorine to the raw sewage to halt further septic action in the tanks and then adding sufficiently more to the tank effluent to give the required residual at the nozzle.

Control of Psychoda—The apparent reduction in the small gray moth flies, *psychoda alternata*, that inhabit trickling filters, produced by the heavy chlorination of the tank effluent applied to one acre of filters during 1925, led to plans to chlorinate the entire three acres of beds. The fact that the removal of the heavy gelatinous film from the surface media coincided in time with the reduction in the larvae, pupae and adult fly population of the treated beds, led to the belief that a destruction of this film would remove the habitat and breeding ground of the flies. With this idea in mind and with the knowledge that chlorination would not seriously or permanently hamper the nitrification of the beds, this three-acre study was started in July, 1926, when the flies were so numerous that the writer was tempted to flood the filters to reduce their numbers. Each bed was given a 48-hr. period of treatment with tank effluent dosed at the rate of about 25 p.p.m. At the end of this application, the beds were practically free from the heavy, black surface film that had existed and the nozzles were cleared of their biological growths. The flies gradually decreased in numbers until the end of the fifth day. Larvae counts indicated that a reduction had been made in this stage of the fly life. Great numbers of dead larvae were found in the filter effluent. At the end of two weeks the flies had again increased to the point of a nuisance, and a 24-hr. treatment of strength similar to the first application was given all the beds. A repetition of the previous reduction in fly population and then a gradual increase in numbers was experienced. This two-weeks non-chlorination interval followed by a 24-hr. treatment continued during the entire summer and resulted in a decrease in fly life during the majority of applications. During September, the flies increased greatly in numbers and but little control success was attained with chlorination. The months of the study were extremely sultry and warm and conditions were advantageous for fly development. It appeared at times that breeding was so rapid that control attempts were unwarranted.

Observations on fly control are extremely difficult and conclusions must be drawn with care. Fly development is so dependent on day-to-day temperature change and the presence of the adults in the air and on beds is so tied up with wind and humidity conditions, that a comparison of fly numbers before and after chlorine treatment is sometimes impossible. Larvae counts appear to be the most dependable measure of control success, but it has been found at Schenectady that the center of larvae population shifts from time to time from a plane a few inches below the bed surface, to as deep as a foot into the beds. Larvae counts are therefore difficult.

During the winter of 1926-27, the filter surfaces were exceptionally clear of film, due to the chlorination of the previous summer, and there was much hope for satisfactory fly control during 1927. Plans were laid for chlorination of the acreage, as in 1926, starting very early in the spring before the flies developed in numbers. These plans were carried out for three weeks in July, 1927, but no greater control success was indicated.

Fly extermination with ortho-dichlor-benzene spray has been continued as a routine practice with the same marked success as was obtained in 1925. A mixture of equal parts of dichlor-benzene and kerosene has been found to be as effective for this purpose as dichlor-benzene alone. Kerosene was found effective in destroying adult flies.

Effect of Chlorination on Filter Nitrification—Application of chlorine to the beds at a rate of about 25 p.p.m. resulted in 3 to 6 p.p.m. of residual chlorine at the nozzles during different rates of sewage flow. The immediate effect of chlorination was a sudden drop in stability and oxidized nitrogen content of the effluent of the filters. This efficiency of nitrification gradually rose to normal in about a week after the treatment and, during the balance of the period before the next application of chlorinated tank effluent, was fairly satisfactory. Filter effluent stabilities during the winter of 1926-27, following the intensive chlorination of the summer months, were higher than in the previous winter, when this abnormal condition did not have to be overcome. Oxidized nitrogen content of the effluent was equally high. The heavy chlorination of the summer resulted in marked continuous unloading, which no doubt was responsible for the low stability and oxidized nitrogen results in the samples captured at that time. This summer unloading resulted in a clearer effluent during the winter and spring period, when normal unloading usually occurs at Schenectady. It is also possible that the clearing of much débris from the beds resulted in a virtual increase in capacity of the units and thus improved nitrification conditions. Absence of surface pooling may have been a contributory cause of this increased efficiency.

The intermittent heavy chlorination given the filters during April, May, and June of this year has resulted in more marked reduction in filter efficiency than did the treatments of the past two summers. This can evidently be accounted for by the fact that the treatments were started early this spring, before the beds had reached their peak of efficiency. This early start, coupled with the comparatively cool weather of May and June, has prevented the development of high nitrification in the treated filters. The beds had the excellent physical condition experienced by the one chlorinated section in 1925. The maintenance of the entire filter area without surface film and the complete absence of surface pooling greatly improved the appearance of the plant. The distribution system and nozzles were similarly clear of film and the distribution of the sewage over the filter area was improved.

Acknowledgments—This extended large-scale work involved the use of two chlorinators and large quantities of liquid chlorine, which were supplied by the Wallace & Tiernan Co. and the Chlorine Institute, Inc. The writer wishes to acknowledge the helpful comments and suggestions on the work made by Metcalf & Eddy, consulting engineers to the plant, and the assistance given by the divisions of sanitation and laboratory and research of the New York State Department of Health.

Quality Design and Control of Concrete

Production Control Requirements Affecting Quality Given—Considered from Standpoint of Economy

By Joseph A. Kitts
Kitts & Tuthill, Concrete Technologists, San Francisco, Calif.

CONTROL methods, producing concrete with greater uniformity of quality and more economically than is possible by use of empirical methods, have been carried out with unusual results on projects in California varying from 3,000 to 450,000 cu.yd. in size.

The details of the manufacture of concrete of quality *with economy* are as complex as those of structural design or those of the manufacture of cement and steel. Concrete must be made from different aggregates, for various strengths, densities and weights; for resistance to ice, chemicals and wear; and also of varying workability, flowability and cohesion of the fresh mix.

Considering strength as the only requirement, some measure of strength may be maintained by empirical methods. The most important of these is the water-cement ratio. Both economy and strength, however, cannot be maintained by water-cement ratio control alone. Strength, density, weight, wear resistance and workability depend upon some one or all of the following conditions when considering economy:

Cement quality, content and water-ratio
Quality, shape, size, coarseness or fineness modulus and surface area of aggregates
Character and uniformity of grading of mixed aggregates
Ratio of cement to voids in fine and mixed aggregate
Ratio of sand to voids in coarse aggregate
Accuracy of measurement of aggregates, cement and water
Mixing time and efficiency of mixer
Moisture and temperature of curing
Efficiency and workmanship in placing.

This requires constant, thorough technical and practical control of concrete production which includes cement, aggregate and concrete testing as a routine part of such control.

The saving in cement required by thorough technical control as compared with arbitrary or empirical proportioning, for the same quality, is from ⅓ to 1 cu.ft. per cu.yd. of concrete, or from 25 to 75c. per cu.yd. saving in cost. This saving pays the cost of thorough control on small projects and many times over on larger projects. Where 100 cu.yd. per day or more are being placed, thorough control may be maintained with economy and uniform quality is constantly insured.

Thorough control of concrete production includes constant laboratory control and research tests on the job in co-ordination with the mixing, placing and curing of the concrete; inspecting, testing and sampling of the cement before delivery on the job and at such other times as may be necessary.

The essential control measures for quality concrete *with economy* are:

(1) Preparing specifications covering cements, aggregates, plant, mixing, placing, curing, testing, inspecting and supervising.

(2) Installing adequately equipped testing laboratories consisting of an aggregate testing laboratory at the aggregate plant on major projects or a central cement, aggregate and concrete testing laboratory at the major structure on a project; and field laboratories for moisture tests of aggregates, for slump and workability tests of the concrete and for making and curing test specimens.

(3) Testing aggregates for density, grading, moisture, and organic matter.

(4) Proportioning and testing of aggregate mixtures.

(5) Proportioning and testing of mortar and concrete.

(6) Changing proportions as required by the variation of individual aggregates to maintain uniformity in grading and cement content.

(7) Co-ordinating the laboratory and field measurements; calibrating and adjusting the batchers, inundators, weighing and water devices.

(8) Inspecting the mixing, placing and curing of the concrete.

(9) Testing in the field for slump, workability or flowability, and making test specimens.

(10) Organizing, co-ordinating and supervising the laboratory testing and field control, and maintaining test and production records.

The procedure for testing and calculating must be a simplified and co-ordinated one, eliminating duplication of test measurements and calculations. It is neither economical nor expedient to test for weight per cubic foot, then for density, then for specific gravity, as the labor involved is increased a number of times over that actually required by a co-ordinated test procedure. A comprehensive and simplified development of the physico-mathematics involved is essential to expedient and economical calculation of results from the test data.

Having given certain aggregates, their coarseness and particular uniformity of grading are the features which determine and upon which depend the quality *and economy* of the concrete. The grading and cement content can be determined only by comprehensive tests, and they can be maintained only by constant testing of the aggregates as received on the job from day to day, and by modifying the proportions accordingly. The uniformity of grading should be expressed by a grading curve equation, providing for variation of fineness modulus. Other essentials are, an expedient algebraic method of calculating proportions of the several sizes of aggregates to fit the grading curve; a simplified test procedure for determination of the density and yield of the combined aggregate; and a developed physico-mathematics for the determination of the various physical characteristics and relations of the combination.

Knowing the weights and actual volumes of water, cement and aggregate used in the mix, it is possible, by simply weighing any known volume of the mix, to determine yield, density and weight per cubic foot, the water-cement ratio, cement voids, barrels of cement per cubic yard of concrete, and other ratios readily calculated. The strength of the concrete is determined from tests of specimens at various ages. These indicate to a certain extent the results which may be expected under the same conditions of aggregate grading, cement content, water-cement ratio, placing and curing. Tests from day to day are essential to check the results to detect any flaw in proportioning and mixing operations and to maintain a proper record of the quality of production.

When changing proportions, the new mix should be duplicated in the laboratory and tested to determine the physical characteristics expected of that particular grading and cement content.

The required control procedure is much less complex than this outline indicates. It becomes very simple by co-ordinating and systematizing the test operations. The physics and mathematics involved are simple and all calculations are quickly made. The apparatus required for the physical tests of aggregates and mixtures is simple and inexpensive.

The only empirical theory proposed is for use with reference to uniformity of grading of mixed aggregate. The control procedure should consider all the theories of proportioning and provide complete physical data for analysis with reference to any theory.

Early Example of Winter Concrete Building Construction

Small Building Put Up in 1911 Anticipated in Crude Manner Present Day Methods of Winter Concreting

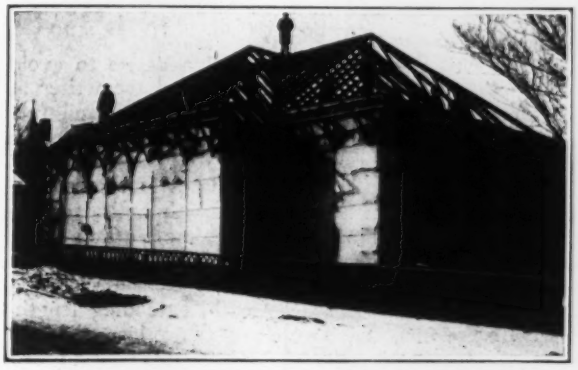
By Ernest B. McCready
Allentown Testing Laboratory, Allentown, Pa.

ONE of the early all-concrete buildings to be put up in winter time is the home of the Allentown Testing Laboratory in Allentown, Pa. It is interesting both because in the iron age of 1911 the idea was scoffed at for any but the largest contractors, and because the work was done at a saving of one-third on the bid offered on the basis of summer concrete work. It was for these reasons that the owner put up the building entirely by day work under his own oversight. Contractors were doubtful about the risk of the job and only one sent in a bid. This was based on summer prices and was too high for consideration. Once work was begun contractors and citizens alike watched closely to see it fall down.

Ground was broken for foundations and footings on Dec. 19, 1911. Until that date the weather had not been unusual, but the two months following are the coldest which the U. S. weather bureau records. The first concrete was poured on Jan. 3, 1912. That night the temperature dropped nearly 30 deg. and stood at 14 deg. below zero at 8 a.m. the next morning. From then until the completion of the work the temperature was never higher than 32 deg. and most of the work was done with the mercury between 8 and 20 deg.

The first floor walls, below the street level but open on all sides, were of concrete. The floors above were of tile and beam construction, with 12x12x6-in. hollow tile placed in rows 16 in. on centers, and the 4-in. space between filled with concrete reinforced with two 1¼-in. flat bars. The floors were 60 by 40 ft. and were supported by beams resting on columns, 12x12 in. for the first floor and 10x10 in. for the second floor.

All materials were heated to insure the melting of lumps of ice and the mixed concrete was placed in the forms at about the temperature of the hand-blood heat. The ice which formed on the surface of each day's work was melted with hot water and the mixture was thoroughly puddled both before and after beginning to pour the freshly mixed concrete. Because the weather was so uniformly cold no attempt was made to prevent the concrete from freezing, but as soon as the first floor was poured a fire was started in the enclosure underneath and maintained continuously for five days. In a few hours the thawing of the frozen concrete was evidenced by the dripping of water from the forms. The average temperature of the air varied from 40 deg. at the floor to 90 deg. at the ceiling. After five days parts of the form were removed at several points and the concrete was heated with a blow torch and the hardness tested and found to be satisfactory. The procedure was followed for the next floor, but, as this was of skeleton



MUSLIN HOUSING FOR CONCRETE BUILDING ERECTED IN 1912

construction, the space was enclosed with heavy unbleached muslin to confine the heat.

Finally the roof was framed and anchored to bolts set in the concrete at the time of pouring and in such a way that it could be raised as a unit for enlargement at any future time. In 1924 this enlargement took place when the second floor above the street was added. At this time the settlement of the building was about 1 in.

Progress of Water Treatment in Chile

By the end of 1927, almost 2,000,000 people in Chile will be using safe water supplies, according to John D. Long, surgeon, U. S. Public Health Service, in an account of his recent work as technical advisor in public health to the Chilean Ministry of Hygiene, published in Public Health Reports, June 17, 1927. Dr. Long's statement on water supplies follows: "A study of the water supplies of the entire country was made. As a result it was concluded that out of 75 public supplies, four could be considered as reasonably safe, the remainder doubtful or dangerous. Following this study, chlorination apparatus was ordered and installed in the cities of Santiago, San Antonio, Concepcion, and Cartagena, with a total population of about 700,000. Apparatus was ordered installed in 23 other cities, including Valparaiso, with 200,000 inhabitants; and before the end of 1927, all these cities should have safe water. The number of inhabitants that will use this safe water will total about 1,250,000—between one-third and one-fourth of the total population of Chile. In addition to the chlorinated supplies, the water systems of several other cities were improved and extended, and safe sources were secured; and during the present year other supplies will be improved in the same manner. All this should mean that by the end of 1927 between 1,500,000 and 2,000,000 people will be using safe water in sufficient quantity."

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Arcless Electric Furnace Developed on Hydro-Electric Job

By Harold K. Fox
Superintendent of Construction, San Joaquin Light & Power Corp., Fresno, Calif.

AVAILABLE electric power and a desire to avoid hauling oil over mountain roads led the writer to develop an electric furnace rather than use an oil furnace for heating drill steel on the Balch hydro-electric project.

After several unsatisfactory furnaces had been constructed, one was finally developed with radical departures in design, eliminating the weaknesses and inefficiencies found in the first furnaces constructed. As finally built, it contained three heating elements, 40x1⅝ in. in size, of 17-kw. capacity each, extending lengthwise with the furnace. Two elements are located in the top of the furnace chamber and the third is placed below the drills in a position where the falling scale cannot reach it.

A maximum temperature of 2,300 deg. F. can be obtained, although 2,250 deg. F. is the highest temperature required. This working temperature is maintained by automatic control, one element being "on" continuously while the other two are "on" intermittently. The current used is 3-phase, 110 volts.

The electric furnace provides better heat control than is possible in fuel furnaces, resulting in a better quality of forging and better tempering. The cost of operation is less than with oil where compressed air is required.

ELECTRIC FURNACE DEVELOPED ON BALCH PROJECT

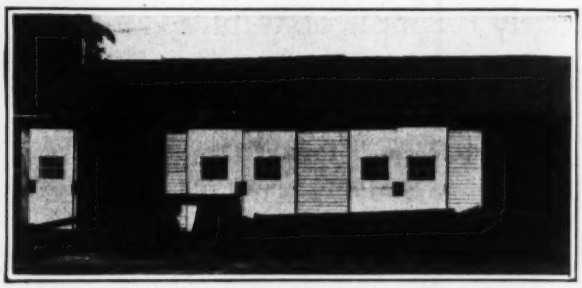
There is no abrasive action of a flame on the lining of the furnace and less scaling, with a corresponding decrease in consumption of steel. Another advantage in using the electric furnace is the elimination of excessive noise, heat and dirt. It has given thorough satisfaction after operating 24 hr. a day for a period of several months.

Assisting in the development of this furnace were A. Pfau, Jr., of the American Resistor Corporation; James H. Knapp, of the James H. Knapp Co.; E. L. Fox, tunnel superintendent, and B. E. Anderson, electrical engineer.

State Rents Trailer To Contractors

By C. D. Buck
Chief Engineer, Delaware State Highway Department

FOR THE past two years the Delaware State Highway Department has owned a 20-ton trailer which it has been renting to contractors for use in hauling heavy loads on state highways. The trailer has a loading deck 18 ft. long and 9 ft. 2 in. wide with a road clearance of 8½ in. The rear wheels are equipped with large internal expanding brakes. The frame is constructed of 8-in. steel H-sections. The deck is made of 4-in. white oak. The weight of the trailer without a load is 10,000 lb.



TRAILER SHOWING HEAVY TYPE OF CONSTRUCTION

The trailer is rented to contractors at a rate of $75 per day, which includes the services of a state policeman to accompany it when used on the highways. The trailer is not used on Sundays, holidays, or when traffic is heavy.

Spreaders for Hoisting Long Loads

IN HANDLING such long articles as timbers and rails, considerable use is made of spreaders or beams which are hung from the crane hook and which carry the chains or slings to be attached to the load. This arrangement, giving two points of attachment, increases the safety and efficiency of hoisting. Some different kinds of spreaders are noted in the following extract from the report of the committee on Safety Practice, presented at the recent convention of the Purchases and Stores division of the American Railway Association:

One type of spreader bar is designed for unloading large timbers of the same length, two at a time. For example: bridge stringers are stored on edge. Invariably they are received on open cars, loaded flat. The spreader is made from two sizes of pipe. The end pieces telescope over the center piece, which is drilled with holes into which pins are placed with large washers between the pins and ends of pipe working against them. The cables attached to the large ring on a crane hook have rings in the ends into which the small hooks on the short cables fasten. The spreader is adjusted to the desired length and serves only to keep the cables apart. As the cables tighten the pipes are pulled out instead of being compressed. The four large timber hooks are then fastened just inside the center of the timbers and when raised the timbers stand on edge. Thus they can be placed against each other on the pile.

Another type is made from 60-lb. rail for handling sling loads of lumber and sills. The cables, attached to a large ring working from the crane hook, are fixed to the ends of the rails.

Double hooks, over which the sling loops hook, are also secured to the rail. Through the large ring is also fastened a cable hanging down and furnished with a hook. This hook is to lift the ends of the timber in order to place the cable slings under it. In unloading, a chain is worked in between the ends of a number of pieces. This end is then lifted high enough so that the two sling cables can be placed under them. The lift is then lowered, chain removed, cable loops placed over the hooks on the ends of rail and lumber or sills are unloaded without a possible chance of a piece shooting out, as occurs in many cases where only a choker hook is used.

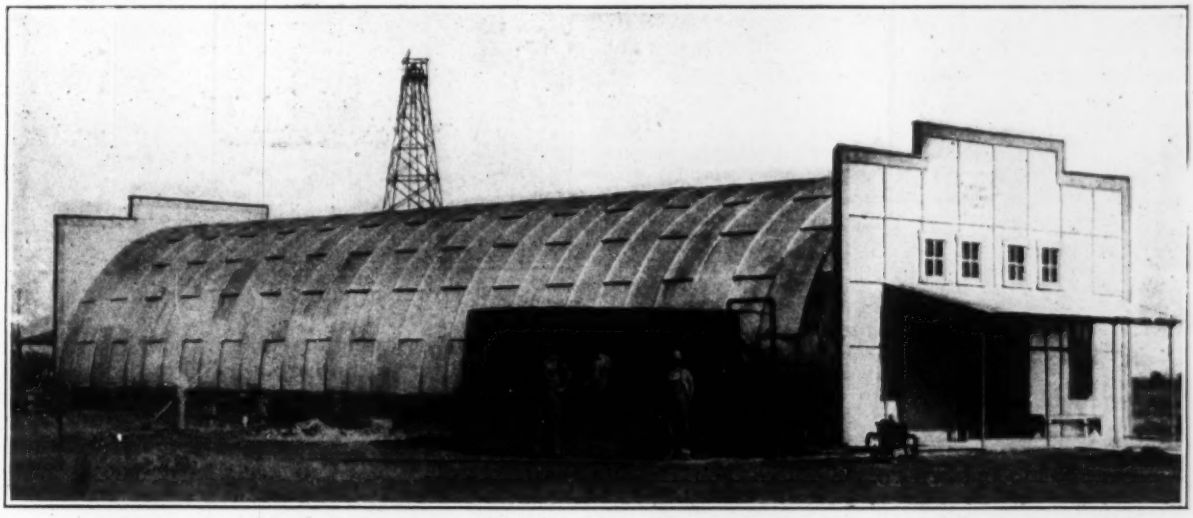
Another type, used for handling frogs, is made from 4-in. pipe, having a steel cap over each end with an eye on the top and the bottom. Cables from the large ring over the crane hook are fastened in the top eyes and rail tongs in the lower eyes. This keeps the tongs spread and eliminates the use of dragging chains out to the ends of frog to hook them.

Oil Field Buildings Built of Old Storage Tank Plates

A PRACTICAL use to be made of steel storage tank plates that are too badly corroded for safe oil storage is adapting them to oil field building construction. The Empire Companies, Bartlesville, Okla., recently developed this scheme in order to dispose of such junk tank-plate material.

The illustrations show the exterior and interior of a power house in the Eldorado, Kas., oil field. This particular power house is 28 ft. wide, 80 ft. long and 11 ft. high at the center. It was not necessary to roll the plates since they had been cut from 28 ft. diameter tanks. The plates were first cleaned by burning and were then assembled with ordinary tank bolts. Watertight joints were made with a fiber roof cement applied from the inside. The ends of the buildings are made with the rectangular and sketch plates from the old tank bottom.

The buildings are painted inside and out with aluminum paint and are fireproof. It is claimed that these buildings are no hotter in summer than those of ordinary construction.

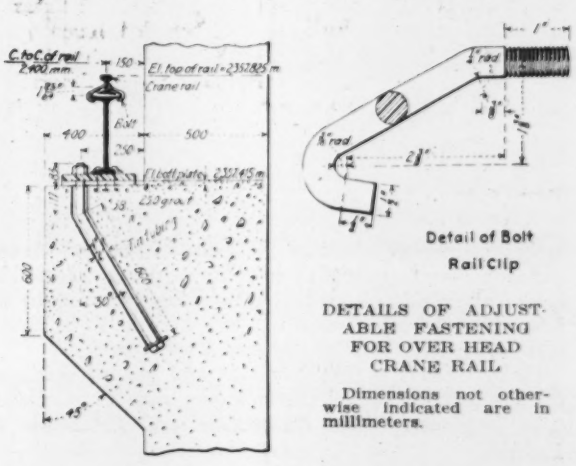


OIL FIELD POWER HOUSE MADE FROM JUNKED STORAGE TANK PLATES

INTERIOR OF STEEL PLATE BUILDING SHOWING TANK BOTTOM PLATES USED IN END

Convenient Means of Fastening Overhead Crane Rails to I-Beam

RAILS to be used by an overhead crane can be conveniently fastened to the supporting I-beam by short pieces of ½-in. round steel, threaded at one end, so they can be bolted through the rail web and bent at the other end to fit around the I-beam flange, as shown in the accompanying drawing. The bolts are put on in pairs, one on either side of the rail web. The result is an inexpensive fastening that can be put on quickly which has the advantage of being adjustable and yet is very rigid when bolted up in proper position. Adjustment



DETAILS OF ADJUSTABLE FASTENING FOR OVER HEAD CRANE RAIL

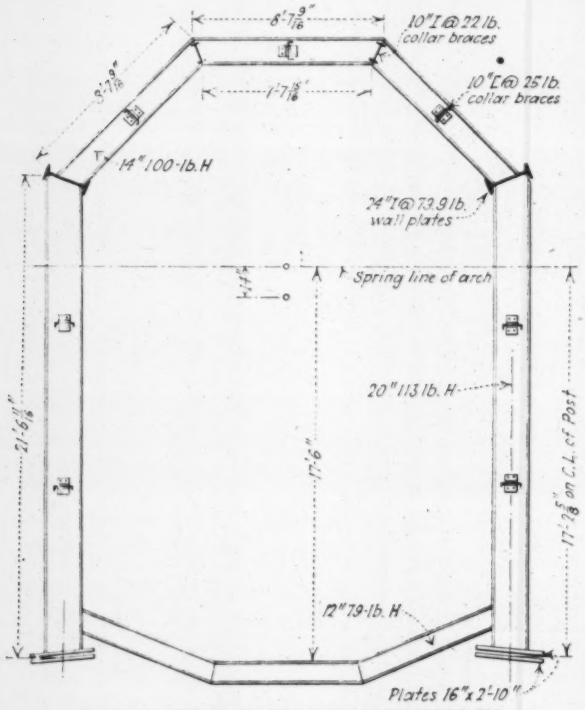
Dimensions not otherwise indicated are in millimeters.

to the desired curve or straight line is made by loosening nuts on one side and tightening up those on the other side.

The details were taken from the design for a crane to handle large gates in connection with a hydro-electric power house on a Mexican project worked out by A. H. Jessup of the Quinton, Code & Hill engineering staff and were made available to *Engineering News-Record* through the courtesy of R. A. Hill.

Steel Lining for Moffat Tunnel Is of Heavy Design

EXCEPTIONALLY heavy steel sets, including invert bracing, are required in part of the Moffat Tunnel, Colorado, as shown in the accompanying drawing. This construction was used for about 900 ft. in the worst ground, and it will be noted that the sets are large enough to provide for a concrete lining on the inside. Thus the clear width between posts is 18 ft. 6 in. and the total height from invert to crown is 26 ft. 9 in., while the standard tunnel section is 16 ft. wide and 24 ft. high above the rock floor. Posts of 20-in. H-beams are seated on base plates 16x34-in. and support 24-in. I-beam wall plates. On these wall plates rest three-segment



HEAVY STEEL TUNNEL LINING USED IN MOFFAT TUNNEL

arches composed of 13-in. H-beams. For the three-segment invert, framed between the posts, 12-in. H-beams are used. Longitudinal bracing includes 10-in. I-beams at the top corners of the arch, and 10-in. channels between the arch segments and side posts.

George Lewis is chief engineer and general manager for the Moffat Tunnel Commission; with C. A. Betts, office engineer. The contractors are Hitchcock & Tinkler.

From Job and Office

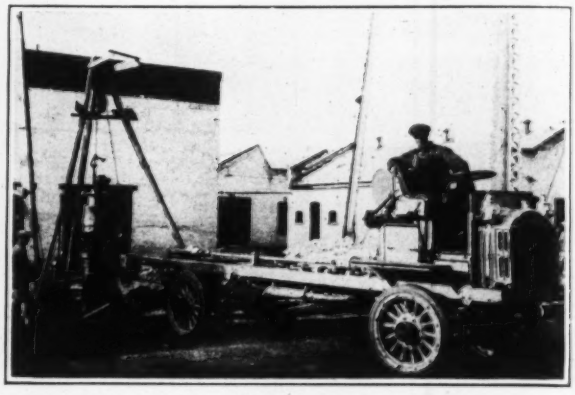
Hints That Cut Cost and Time

Winch on Truck Used in Driving Well Casing

By William E. Clark
De Pere, Wis.

A WELL casing was driven recently by means of a simple rigging and a power winch mounted on a truck, as standard equipment was not available for use on the job.

After a 700-ft. well had been drilled, bailed and



POWER WINCH OPERATED BY TRUCK

cleaned, a 10-in. casing was driven for the first 30 ft. by hand. However, further manual driving was impossible, so a truck equipped with a winch, driven by the motor, was brought into use. An improvised ram, weighing 800 lb., was suspended by a line passing through blocks mounted on an A-frame and around the drum of the winch, which revolved continually. On a signal, the loose end of the line was snubbed onto the drum, raising the ram to the block, when the line was released and the ram dropped like a pile driver. This operation was repeated until the entire casing had been driven. The casing was driven as well as if a standard drill rig had been used.

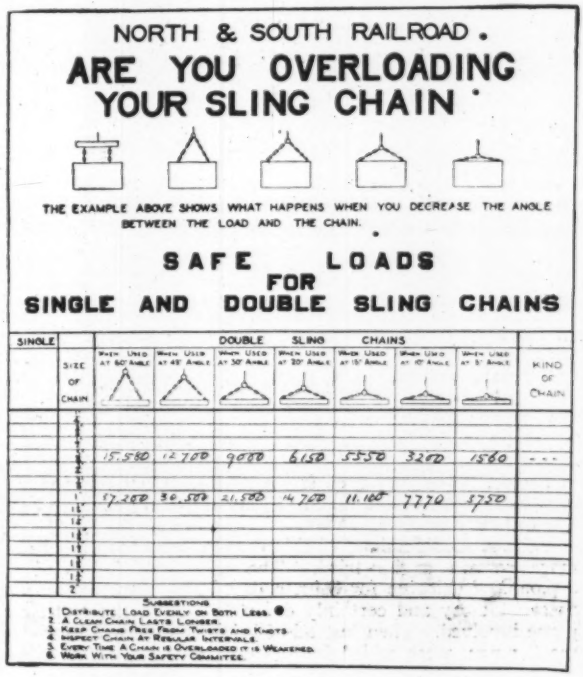
Load Chart for Chain Slings

A FORM of chart for safe loads of chain slings illustrating the effect of decreasing the angle between sling and load, as given in the accompanying illustration, was adopted at the recent convention of the Purchases and Stores division of the American Railway Association, in connection with the report of the committee on Safety Practice. No loads were given, because of the many kinds of chain furnished by different manufacturers. For an example, however, some load figures have been inserted, representing one particular make of chain.

It was the committee's recommendation that the form of chart should be adopted, and that each road should insert figures based on those of the manufacturer of the chain being used. It was also recommended that the charts, with load figures, should be placed in the hands

From Job and Office

For Contractor and Engineer


NORTH & SOUTH RAILROAD
ARE YOU OVERLOADING YOUR SLING CHAIN
THE EXAMPLE ABOVE SHOWS WHAT HAPPENS WHEN YOU DECREASE THE ANGLE BETWEEN THE LOAD AND THE CHAIN.
SAFE LOADS FOR SINGLE AND DOUBLE SLING CHAINS
SINGLE
DOUBLE SLING CHAINS
SIZE OF CHAIN
KIND OF CHAIN
15,580 12,700 9080 6150 5550 3260 1560
17,280 30,580 21,580 14,760 11,160 7770 3750
SUGGESTIONS
1. Distribute Load Evenly on Both Legs.
2. A Clean Chain Lasts Longer.
3. Keep Chains Free From Twists and Knots.
4. Inspect Chain At Regular Intervals.
5. Every Time A Chain is Overloaded it is Weakened.
6. Work With Your Safety Committee.

LOADS FOR DOUBLE SLING CHAINS

of every foreman or hoist engineman using chain slings. This chart is used by the Oregon-Washington Railroad & Navigation Co. (Union Pacific System), and was presented by J. L. Irish, general storekeeper.

Rod Measures Paving Thickness

By R. E. Dodge
San Francisco, Calif.

FOR measuring the thickness of paving or of the surface paving on an old base, a rod similar to a level rod is being used in California. This rod, shown in the accompanying drawing, was designed by engineers of the California Highway Commission and has been used for three or four years. Its special use is on repaving work, over old paving where there is considerable uneven subgrade and little typical section, the thickness of the new concrete merely being kept to a minimum.

The rod consists of two pieces of wood put together like a level rod, with a length of about 5 ft. when closed. The back piece, which forms the base and pointer, has no scale. The front part, which is movable, has a crosspiece at the bottom. Its upper portion is marked with a scale in inches and eighths, reading downward, the initial point on this scale being marked in line with the top of the back piece when the rod is in the closed position. In use, a straight-edge (or templet in case of a crowned surface) is laid across the header boards between which the concrete is to be placed, the rod standing on the subgrade at a point where a measurement is desired in such position that when the movable part of the rod is raised the crosspiece will come in contact with the under side of the straight-edge. Then the thickness of the concrete to be placed at this point can be read directly on the scale.

MEASURING ROD FOR PAVING DESIGNED BY CALIFORNIA STATE HIGHWAY COMMISSION ENGINEERS

Job and Office Notes

In Rebuilding an Old Masonry Dam and raising the water level in a water supply reservoir for the town of Newton, N. J., the old wrought-iron intake was found to be in good condition after over 20 years of service. The intake is 42 in. in diameter and is located in about 30 ft. of water, protected by a pile structure. It was constructed by assembling on the ice and lowering into position. Louis L. Tribus, of Tribus & Massa, consulting engineers, New York City, designed the structure in 1895, and the same firm is a consultant on the work of enlargement.

A Machine which Excavates, Moves and Deposits Earth in a continuous operation, was used on a recent highway contract in California, according to an article describing it in *California Highways*, a publication of the California Highway Commission. The design is by R. E. LeTourneau of Stockton, and provides for one-man operation. Essentially, the machine consists of five telescoping compartments without backs, each 3x3x7 ft. in size, the first having a cutting edge with a vertical movement and being fastened rigidly on a frame mounted on continuous-tread tracks. The vertical movement of the cutting edge, as well as the horizontal movement of the compartment, is controlled by electric motors through rack and pinion driving mechanisms. Motors are driven by current from a generator mounted on a tractor which pulls the machines. They are controlled by switches conveniently located for manipulation by the tractor operator. In loading, the frame is depressed so that the cutting edge on compartment No. 1 is excavating to the capacity of the tractor or tractors pulling the machine. Compartment No. 5 is loaded first and is pulled back by the tail gate, exposing compartment No. 4, which receives its load as compartment No. 5 is receding. Compartment No. 5 moves until its front end rests on the back end of No. 4, when it hooks on to No. 4 and carries it along. This motion continues until the front end of compartment No. 2 rests on the back end of the fixed compartment No. 1, when the machine is fully loaded and appears to have but one compartment 15 ft. long. To unload, the action is reversed; compartment No. 2 slides into compartment No. 1 and so on until compartment No. 5 reaches its forward position inside of the others when the tail gate slides forward and empties the entire load. When operated with one 60-hp. tractor, a load of 8 to 10 cu.yd. is handled, but when a snap tractor is used, 14 or 15 cu.yd. may be moved at one time. Most satisfactory results are obtained when cuts are 200 ft. or more in length and the material excavated is such that it can easily be scarified or plowed.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Sewage Chlorination Beneficial at Singapore

Sir—A paper by Morris M. Cohn on the chlorination of sewage applied to sewage filters of the trickling or percolating type which appeared in *Engineering News-Record* of June 10, 1926, p. 943, evoked great interest in Singapore. The resulting experiments have been so satisfactory that those obtained to date (June 1, 1927) are here submitted. The original purpose of the test was the elimination of ponding on filter beds, caused by a gelatinous film. These tests, however, showed such a remarkable increase in the efficiency of the filter beds that the first purpose has been disregarded.

The Singapore sewage-works include a bellmouth chamber (terminating the rising main), a hand-cleaned roughing screen, 3 detritus tanks, 2 normally being in operation (capacity each 1/260 dry-weather flow), 24 Imhoff tanks of $3\frac{1}{4}$-m.g. capacity at 2-hr. detention, 17 filter beds of 2-m.g. capacity at 90 gal. per cubic yard per day, and 3 humus tanks. [Presumably, imperial gallons are used throughout this letter.—EDITOR.] The media of the 8 13-year-old filter beds is 2 to $2\frac{1}{2}$-in. gage coral. The material of the other 9 beds is $1\frac{1}{2}$-in. gage granite and these are $2\frac{1}{2}$ years old. Each bed has a diameter of 100 ft. and a depth of 6 ft. The sewage is distributed over the beds by means of revolving sprinklers. The average amount of sewage treated by the works is $2\frac{1}{4}$ m.g.d. The sewage is strong domestic sewage with a little subsoil water and no trade wastes. The crude sewage contains on an average 850 and the Imhoff tank effluent about 270 p.p.m. of suspended solids. The latter contains about 70 p.p.m. of free ammonia, 8 p.p.m. of albuminoid ammonia and absorbs about 65 p.p.m. of oxygen from acid permanganate in 4 hours at 85 deg. F.

The condition of the coral beds at the commencement of the experiment might well be considered deplorable. They had been neglected and deliberately overworked for some time as the intention was to replace the coral by granite at the earliest possible date. The remarks of the acting sewerage engineer at the commencement of the experiment are illuminating: "I am of the opinion that the old coral beds have gone too far and are beyond rejuvenation. . . . While I admit that the removal of the gelatinous film would help matters considerably I am firmly convinced that all the old beds require renewal of media." This opinion was shared by many others connected with the sewage-works, but it was felt that experiments with chlorine, which were considered to be drastic, might at any rate be tried on beds which had been condemned.

The granite beds had been nursed very carefully, but results were only fair. The beds were certainly not working up to full capacity (50 gal. per cu.yd. per day only) and were in many ways disappointing. The gelatinous film was most marked on the old coral beds, while the new granite beds did not show this film to any marked degree.

Chlorine water was manufactured, by solution of the gas, in strengths ranging from 0.2 to 0.3 per cent of free chlorine; the latter was the strongest solution it was practicable to make in this hot climate. As it was anticipated that all the chlorine would be taken up before it reached the filters, if it was applied at the outfall from Imhoff tanks, the first experiment consisted of adding the chlorine water to the central revolving drum of one of the old coral beds by means of a gaging box at the rate of 2 p.p.m. of free chlorine. This bed was so dosed for 8 hr. per day over a period of 17 days.

About the third day a very marked improvement was noted in the effluent, and for the first time for many years a clean bright filtrate was obtained. Comparison of analyses of samples from the chlorinated coral bed and from the untreated coral beds showed that the treatment reduced the free ammonia from 12 to about 6 p.p.m., the oxygen absorbed from 13 to about 6 p.p.m. and the suspended matter from 35 to about 20 p.p.m. The nitrates were increased from 6 to 15 p.p.m.

The results for the whole run may be summarized as follows: (1) Great decrease in "oxygen absorption"; (2) suspended matter lower, except when first doses of chlorine were liberating humus; (3) orifices on distributing arms cleansed; (4) fresh clean smell on filter; undoubtedly slight traces of free chlorine present; and (5) gelatinous film showed signs of breaking up. At the same time a piece of the gelatinous film was kept immersed in chlorine water (about 0.25 per cent). After a few days this film was found to be broken up into a flocculent state from which it gradually disintegrated.

The same experiment was transferred to a granite bed for 34 days, and similarly encouraging results were obtained. The surface of the bed rapidly cleaned up but it was found that the penetration was only slight. It was also noticed that the dose did not kill off the mites and other small indigenous animal life.

Owing to these good results it was decided to chlorinate all the filter beds. A manometer type chloronome was installed to discharge into the outfall from the Imhoff tanks. The dosage at first was 2 p.p.m. for a period of 8 hr. per day. Although no free chlorine could be detected at the beds (ortho-tolidine test on liquor from nozzles), the filtrate improved to the same marked degree as in the preliminary experiments. This improvement has continued to date (that is to say, for a period of six months). On occasions the analytical figures have fallen off, but this has generally been due to heavy rain.

Various modifications of this dosage have been tried and more remain to be tried. The dose was increased to 3 p.p.m. of chlorine for 8 hr. a day. The results were not as satisfactory and certainly did not warrant the extra expense involved. Then instead of being added for 8 hr. a day the 2 p.p.m. were added for the whole 24 hr. The results again were not so uniform or so satisfactory. Finally, periods of rest from chlorination were given. The Imhoff tank effluent was chlorinated for a week at 2 p.p.m. for 8 hr. a day and then chlorination was stopped for three weeks. The filtrate showed very slight signs of falling off for the first week or two, and at the end of the period of rest the "oxygen absorbed" figure had only risen to be 10 p.p.m. On resumption of chlorination the filtrate quickly recovered and the "oxygen absorbed" fell to 5 p.p.m.

The conclusions drawn from the wholesale treatment of the Imhoff tank effluent with chlorine may be summarized as follows: (1) No decrease of gelatinous film; (2) slight decrease of ponding (the beds require constant supervision and occasional raking over to attain this end); (3) no free chlorine at the nozzles of the revolving arms, so it would appear that it is the chlorination of the tank effluent, and not free chlorine, that is doing the useful work on the beds; (4) great increase in the nitrifying activities of the beds with this small dose of chlorine; (5) oxygen absorption figures low; and (6) coral beds, which were formerly considered finished, will probably last a few years more.

Preliminary bacteriological tests indicate that the number of de-nitrifying organisms is reduced by the action of free chlorine and that the nitrifying organisms are not so reduced. It may therefore be suggested that the chlorine has a selective action on the organisms in the sewage, destroying or rendering less powerful those which are harmful in the purification processes and not affecting those which have a beneficial action, such as nitrifying organisms, to anything like the same degree. It has been suggested that it is the production of nascent oxygen which has this effect on the organisms and that the chlorine itself in this very low dilution does not show its disinfecting effect. This may explain why the de-nitrifying and not the nitrifying organisms are attacked.

A. G. HARRINGTON AND
C. E. WHITTAKER,
Municipal Analyst and Assistant Sewerage Engineer, Straits Settlement.

Singapore, July 1, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Consulting Board is Named for Reclamation Dams

Wiley, Henny and Nalder to Aid Bureau Engineers on Owyhee, Deadwood and Gibson

A BOARD of consulting engineers has been appointed by Elwood Mead, Commissioner of Reclamation, for the purpose of considering and reporting upon various matters in connection with the design and construction of three large dams planned for early construction or already under way by the Bureau of Reclamation, as follows: Owyhee dam in Oregon, Deadwood dam in Idaho, and Gibson dam in Montana.

The members of this board are: A. J. Wiley of Boise, Idaho; D. C. Henny, of Portland, Oregon; and W. H. Nalder, of the Denver office of the Bureau of Reclamation. Associated with these in the consideration of the respective dam sites will be the following: at Owyhee, F. A. Banks, construction engineer; at Deadwood, R. J. Newell, project superintendent, Boise project; and at Gibson, George O. Sanford, project superintendent, Sun River project, and Ralph Lowry, construction engineer.

The Owyhee dam is to be located in a canyon section of the Owyhee River about 20 miles above its mouth, and will have a total height from foundation to parapets of 360 ft., making it 11 ft. higher than Arrowrock, completed by the Bureau of Reclamation in 1915. Owyhee dam will provide a storage capacity of 595,000 acre-ft. of water, to be used for the irrigation of 124,000 acres of land, a portion of which is now afforded a partial water supply from the Owyhee and Snake Rivers.

Dr. Warren H. Smith, geologist, of Eugene, Oregon, has been appointed as a consulting geologist to examine and advise as to the geological conditions disclosed by the recent diamond drilling. It is expected that he will make his examinations of the field conditions immediately in advance of the meeting of the board and it is hoped that he will be present at the time the board meets to give advice.

Deadwood dam is planned to raise the water surface of the Deadwood River, a tributary of the Payette, 113 ft., forming a reservoir with a storage capacity of 101,000 acre-ft., to provide storage for the Black Canyon Division of the Boise project and adjacent lands. Estimates have been prepared for two types of dam, a concrete arch and an earth and rockfill embankment. The principal duty of the engineering board will be to advise as to the more suitable of these two types.

Gibson dam, contract for the construction of which has been awarded to the Utah Construction Co., will be of the massive concrete arch type with a maximum height of 195 ft. and a crest length of 900 ft. It will store 90,000 acre-ft. for the irrigation of lands on the Sun River project of the Bureau of Reclamation. Excavation for the base of the dam and the spillway was begun by the contractor in December, 1926, and has progressed to a point where it is desired to start concreting in a short time.

The matter to be given consideration here by the engineering boards have to do with the suitability of foundation conditions as now exposed, the extent of additional work to be done on the foundations before concreting is begun, the suitability of the contractor's plant for producing from the available materials uniform concrete of the required strength and durability, and the precautions that must be exercised by the construction engineer to insure the best quality of concrete in the structure. The work that has been done for the foundation grouting is also to be considered and any advisable changes outlined.

Engineering Fifty Years Ago

From *Engineering News*, August 11, 1877

ONE of the latest Yankee ideas is a Turkish bath on wheels. It is a car that can run behind the sleeping-coaches of an express train. It has a drawing room, a Russian and plunge bath, shampooing rooms, and all the other accommodations of a Turkish bath-house. The temperature of the rooms varies from 80 deg. to 160 deg. and the compartments are lighted from the roof with blue glass. Travellers can bathe as well as eat, drink and sleep on the rail. Such a car can be switched off on a sidetrack in any town or village and remain a day or two for the accommodation of the residents.

San Gabriel Dam Bids Rejected in Favor of Higher Dam

Facing a suit to enjoin them from awarding a contract for the construction of the 180,000 acre-ft. San Gabriel dam recommended in the Marx-Fowler-Paul report, the Los Angeles County board of supervisors has rejected bids on a dam of this size and has ordered the chief engineer to prepare plans for a 240,000 acre-ft. structure (see *Engineering News-Record*, July 28, 1927, p. 157).

Johnson Dismissed from Wanaque Work

Snow Report Supports Johnson on Use of "Smooth-Bore" Steel Pipe

AFTER a lull of a few weeks in the Wanaque watershed and aqueduct controversy the North Jersey District Water Supply Commission, which is acting as agent for Newark, Paterson and six other communities in developing a new water supply, voted unanimously on Aug. 8 for the immediate discontinuance of the services of Col. George A. Johnson, New York City, as engineer for the aqueduct. Two days later, the commission made public the report of F. Herbert Snow, consulting engineer, Harrisburg, Pa., on the points at issue between Col. Johnson and Arthur H. Pratt and Morris R. Sherrerd, chief and consulting engineers to the commission. Mr. Snow's report, which will be summarized in a later issue, upholds Col. Johnson as to the yield of the watershed being less than estimated by Messrs. Pratt and Sherrerd; as to the omission of the aerator at the Wanaque dam (except as a landscape feature), to the end that the full head of the reservoir may be utilized; and as to use of twin "smooth-bore" steel pipe lines for the major part of the length of the aqueduct, instead of a single aqueduct, partly of plain concrete at grade and partly by riveted steel pipe, and also as to the use of $n = 0.013$ for the "smooth-bore" steel pipes—which Messrs. Pratt and Sherrerd contended was far too low; but although supporting Col. Johnson as to the value of n, Mr. Snow advises that the size of the twin pipes in the Johnson plan be increased from 72 to 74 in. from the Wanaque dam to the Paterson offtake at Little Falls, from 60 to 72 in. from Little Falls to Bloomfield, and that from Bloomfield to the terminal reservoir in Belleville two instead of a single 72-in. pipe be used, with perhaps only one built at present. Mr. Snow's general conclusion as to cost of the aqueduct under the Pratt-Sherrerd plan and under the Johnson plan as modified by Snow is that it will be about the same.

Robert E. Horton, consulting engineer, Albany, employed by Mr. Snow to report on the value of n, submitted an extended discussion of the subject backing up Mr. Horton's 1916 conclusions, except that he now puts n at from 0.013 to 0.014 (instead of 0.013) and, like Mr. Snow and Col. Johnson, assumes that the pipe would be kept in good internal condition by cleaning.

Action by the commission on Mr. Snow's report is expected to be taken on Aug. 11.

Banks Close in Dispute Over Los Angeles Water Rights

There are five banks in the several towns of Owens Valley, Calif., and all five discontinued business on Aug. 4, posting on their doors the following notice: "We find it necessary to close all of our banks in Owens Valley. This result has been brought about by the last four years of destructive work carried on by the city of Los Angeles." The banks are all controlled by the Watterson interests, prominent in negotiations between the Valley and the city of Los Angeles in the matter of water rights.

Some Louisiana Land Still Under Water from Broken Levees

Rivers within the New Orleans district are all within the bankful stage, according to the Aug. 1 special flood bulletin of the New Orleans office of the Weather Bureau, but the drainage of flood water from low-lying land areas is slow and it is estimated that from 30,000 to 35,000 acres of agricultural land are still under water in Louisiana. Considerable areas of swampy bottoms with a small percentage of farm land are still under water in the Tensas basin, the principal portion of this overflow lying in Tensas, Concordia and Catahoula parishes.

Below Red River a large area in the central and lower Atchafalaya basin in the vicinity of the main stream and the lakes is still inundated with considerable agricultural land under water or too wet for cultivation, mostly in St. Martin, Iberia, St. Mary and Terrebonne parishes. West of Bayou Teche and also in the Tensas and Atchafalaya basins, there are flooded depressions with some agricultural land included from which relief from flood waters will be slow, mostly by percolation and evaporation.

I. C. C. Approves Short Line Extension in Texas

The Interstate Commerce Commission on July 21 issued an order permitting the Waco, Beaumont, Trinity & Sabine Ry. to extend its line from Livingston to Port Arthur via Beaumont, Texas, a distance of 100 miles. It has also permitted the road to extend its line from Weldon to Waco, Texas, a distance of 109 miles, together with a Beaumont belt about six miles in length making a total new construction of 215 miles entailing an expenditure of $11,000,000.

The approval was given in the face of opposition by the Loree interests and the Kansas City Southern Railway. The president of the Texas line, Col. R. G. Duff, has continually fought the Loree Southwestern rail merger. Construction of the road between Beaumont and Port Arthur is permitted only in case satisfactory arrangements for use of existing rail and terminal facilities in the Beaumont-Port Arthur district and at Port Arthur can be arranged. The construction contingency into Waco is the obtaining of tracking rights over existing lines between Mart and Waco. The case was won on a rehearing. After the decision Colonel Duff proposed to the commission that his road be allocated to the Loree system either as part of the Katy or of the Kansas City Southern. A similar offer was also made to the Missouri Pacific. Both offers were refused.

Mount Hope Bridge to Proceed

Financing of the Mount Hope toll bridge project, between Bristol and Portsmouth, R. I., has been definitely arranged. A group of bankers headed by William R. Compton Co., 44 Wall St., New York, and Peabody, Houghteling & Co., will provide the money. Robinson & Steinman, of New York, have been retained as engineers for the bridge, a suspension structure of 1,200-ft. span. It will cost about 3½ millions. Bids are to be asked next month.

American Engineers to Assist Russian Developments

A recent contract between the Freyn Engineering Co., Chicago, and the soviet government of Russia, provides for consulting engineering service in the development of iron and steel works in that country. This will include the preparation of plans and supervision of construction for new plants and the rehabilitation of old plants, under a five-year budget of about $350,000,000 for the works themselves and such auxiliaries as industrial cities providing modern accommodations for the workmen. An engineering commission headed by John A. Garcia has been sent to Russia by the Allen & Garcia Co., consulting engineers, Chicago, this company having been retained by the Union of Socialistic Soviet Republics, through the Amtorg Trading Corporation, to lay out coal-mining plants according to American practice.

Chicago Opens Large Water-Works Pumping Plant

One of the largest water-works pumping plants in the world was put in service Aug. 4 with the formal opening of the pumping station at Western Ave. and 49th St., Chicago. Four centrifugal pumps driven by compound steam turbines have each a capacity range of 50 to 75 m.g.d. and a total head range of 107 to 150 ft. One pump is for reserve and ordinarily there will be two or three pumps in regular operation. This plant was designed in the Bureau of Engineering under the direction of the late John Ericson, city engineer; J. J. Versluis was engineer in charge of construction. An extended account of this station and the design of its pumping equipment was given by L. D. Gayton, engineer of design, in *Engineering News-Record*, May 27, 1926, p. 838.

San Francisco to Ask Congress for Bay-Bridge Permit

On Aug. 1 the San Francisco board of supervisors instructed the city attorney to prepare a bill for presentation to Congress next December, asking for a permit to build the proposed transbay bridge from Rincon Hill to Alameda Mole. There has been considerable discussion before the board of supervisors on the question of whether the financing of the proposed structure should be attempted under a public ownership plan

Grand Trunk Ry. to Rebuild Line Into Detroit

An agreement between the state of Michigan and the Grand Trunk Ry., signed by the governor on July 21, provides for relocation and grade separation on about eight miles of the line between Royal Oak and Birmingham, Mich., forming part of the line into Detroit, to allow of widening the Woodward Ave. superhighway to 204 ft. between Detroit and Pontiac. For this distance the Detroit, Grand Haven & Milwaukee Ry. (Grand Trunk Ry. System) occupies a right-of-way parallel with and adjoining Woodward Ave., and in order to widen this thoroughfare as a trunk road and to open up frontage on both sides, it was necessary to get the railway to remove its line further east. The new right-of-way is to be obtained by the state, which will also pay the cost of reconstruction, the railway company repaying this cost by a series of annual payments of $250,000. While the present line is at street level and has numerous grade crosings, the new line will be elevated and will have thirteen subways and only two grade crossings.

Need for More Topographic Maps Emphasized by Flood

Lack of topographic maps of the lower Mississippi Valley made it difficult during the recent floods to give warning in advance as to the territory about to be inundated, according to the Department of the Interior. Congress has restricted the expenditures under the appropriation for topographic mapping almost entirely to state co-operation and as the state of Louisiana has not co-operated in this work for a number of years, the Geological Survey has not made any recent progress in mapping the state. A conservative estimate of the cost of mapping the 70,000 square miles in Louisiana, Mississippi and Arkansas on standard field scale with contour intervals appropriate to the relief is $50 per square mile or $3,500,000. A five-year program has been recommended with appropriation of $700,000 per year until the work is completed. It is also stated that the first work should be in those areas immediately to the west of the Mississippi River embracing the lateral streams which may be used as spillway channels.

Railroad Expenditures for 1927 Will Be About $700,000,000

Capital expenditures by the railroads for new equipment and additions and betterments to property amounted to $155,022,000 in the first three months of 1927, according to special reports filed by the Class I railroads with the Bureau of Railway Economics. This is a decrease of $10,678,000 compared with the corresponding period last year. From the foregoing figures it would appear that capital expenditures for the year 1927 will approximate from $700,000,000 to $750,000,000.

In the first three months equipment expenditures amounted to $55,346,000 which was a decrease of $19,554,000 compared with the first quarter in 1926. It was stated that this decrease was largely due to a reduction in expenditures for freight cars, for which only $18,192,000 was expended compared with $44,500,000 in the first quarter of 1926, and $73,300,000 in the first quarter of 1925. The expenditures during the first three months of 1927 were greater for both locomotives and passenger cars than for the corresponding periods of 1925 and 1926.

Expenditures of $99,676,000 for roadway and structures in the first three months represented an increase of $8,876,000 over the same period last year.

Total expenditures for additional track in the first three months of 1927 amounted to $30,145,000 compared with $30,900,000 during the corresponding period last year.

Seattle Ready for Diablo Dam Construction

The city of Seattle has announced through W. C. Morse, city engineer, that specifications will be ready for contractors on Aug. 10 on the proposed Diablo dam. The city has recently built a railroad to this dam site and development here will be the next step in the municipal hydro-electric development on the Skagit River.

Bids are to be opened at a date not yet announced but about three weeks after the specifications are given out. The Diablo dam is to be 385 ft. high, 1,100 ft. long and will contain about 250,000 cu.yd. of concrete. The initial capacity of the Diablo power house, which will probably not be begun for another year, will be 40,000 hp. and the ultimate capacity 240,000 hp.

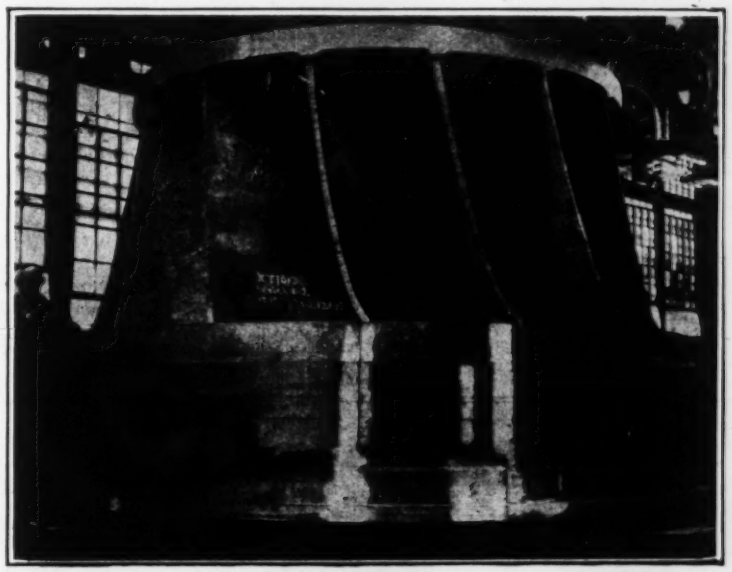
Argentine Government Calling For Bids on Railway

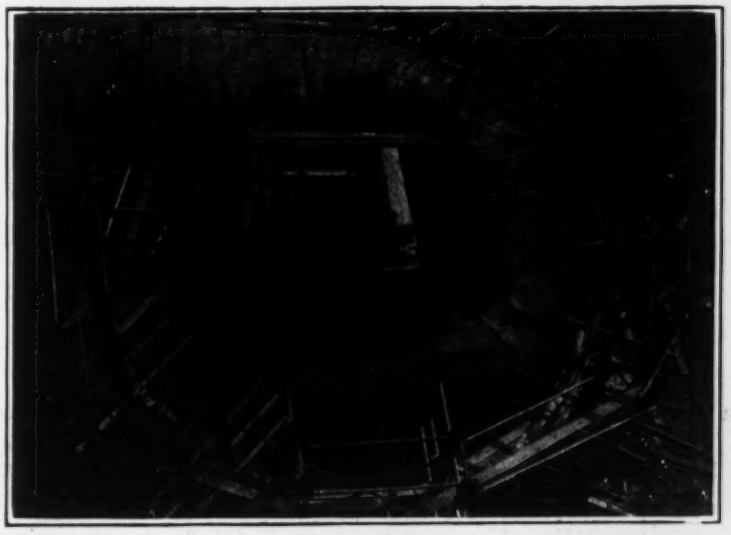
The Argentine Government State Ry. is calling for bids on three railway extensions, having a total length of about 450 miles. The new lines are from Formosa to Embarcacion, a distance of 401 km. of meter-gage railway at an estimated cost of 17,634,000 paper pesos to be completed in 18 months' time; an extension from Metan to Barranqueras, a distance of 362 km. to be completed in 15 months at an estimated cost of 12,072,000 paper pesos; and a line from Cordova to LaPuerta, 121 km., to be completed in one year at an estimated cost of 4,486,000 paper pesos. The value of the Argentine paper peso is approximately 42 cents. All the new lines are to be of meter gage laid with 37-kg. rails and the work includes 35 passenger stations, warehouses, fences, telegraph lines and auxiliary installations. Plans and other information can be obtained from the Argentine Embassy in Washington. Bids are to be in by Sept. 15, 1927.

Saluda Project License Executed

The license covering the $20,000,000 Saluda River project of the Lexington Water Power Co., of Columbia, S. C., was executed Aug. 8. As the final plans for the dam, powerhouse and spillway have not been completed in all their details, the license gives a period of six months for the submission of these plans. The dam, which will be at Drehers Shoals, will be 183 ft. high, creating a reservoir which will contain 1,725,000 acre-ft. of usable storage. The ultimate installation will be 260,000 hp.

RECORD-BREAKING TURBINES FOR CONOWINGO





ABOVE is shown one of the 54,000-hp. turbine runners for the Conowingo plant of the Susquehanna River in Maryland partly assembled in the shop of the Allis-Chalmers Manufacturing Co. at Milwaukee. Below there is shown the plate-steel volute casing for another unit being assembled in the Philadelphia shop of the I. P. Morris Corp. These are the largest turbines ever built as regards physical dimensions but their capacity has been exceeded by units built to operate under the higher head available at Niagara Falls.

Welding Society Outlines Fall Program

For its fall meeting to be held in Detroit, Mich., at the Book-Cadillac Hotel, Sept. 19 to 23, 1927, the American Welding Society announces a tentative program, to include the following papers:

Report of San Francisco Section's Investigation on Study of Welds Subjected to High Temperatures.

Heat Treatment by the Oxy-Acetylene Flame, by E. E. Thum, associate editor, *Iron Age*.

A Metallurgical Study of Welds, by G. R. Brophy, Research Laboratory, General Electric Co.

Car Welding, by Victor Willoughby, general mechanical engineer, American Car & Foundry Co.

Welding of Structural Steel, by Joseph Matte, Jr., of Albert Kahn, Inc.

Welding in the Design of Steel Plate Work, by L. J. Sforzini, Engineering and Maintenance Department, Eastman Kodak Co.

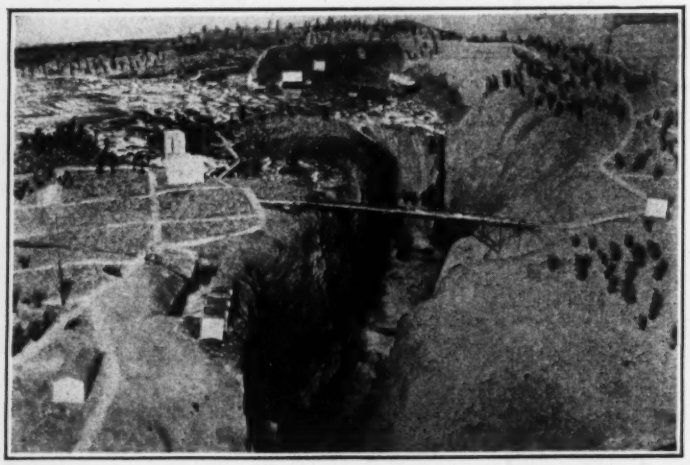
Chesapeake & Hocking Ry. Work Makes Good Progress

The 63-mile line now under construction from Greggs, Ohio, on the Chesapeake & Ohio Ry., north to connect with the Hocking Valley Ry. at Valley Crossing, is expected to be ready for traffic in September, according to schedule. When construction started late in November, 1926, the grading and masonry were scheduled to be completed in 150 working days, and work has progressed rapidly in spite of delays due to heavy rainfall and bad weather. Up to June 16, the grading was 88.5 per cent completed; masonry, 90.3 per cent; culvert and sewer pipe, 91 per cent; track, 25.9 per cent, and structural steel, 17.7 per cent. The work is divided into eight sections under seven contractors. It is in charge of W. Michel, chief engineer, Hocking Valley Ry., Columbus, Ohio, with eight resident engineers. This new railway is designed as a low-grade line, particularly for heavy northbound coal traffic. It will have ruling grades of 0.2 per cent against northbound and 0.5 per cent against southbound movements.

Southern California Visited by Slight Earthquake

The first earthquake suffered by southern California in seven months was recorded Aug. 4. The shock, which is reported to have lasted from 10 to 45 seconds, visited Los Angeles, San Pedro, Hollywood, Santa Monica and coast towns from Ventura south about 50 miles. The damage was said to have been slight, a broken water main being reported as the chief damage done in Los Angeles.

Model of Niagara Falls and Power Developments, Built at University of Iowa



STUDENTS of watt-power engineering at the University of Iowa built the model shown herewith in a frame or tank about 10x10 ft. It is on a horizontal scale of 1:875 and a vertical scale seven times as large, or 1:125. Topographic maps in conjunction with photographic views were used as data. Water is circulated by a small motor-driven pump from a sump at the downstream end of the river (a short distance above the head of Whirlpool Rapids) to a discharge pipe at the upstream end (near the Upper Rapids), in volume representing mean flood-time discharge. Some of the power developments have been built in, and others are to be added later. The model serves primarily to bring out by hydraulic power relations in definite form for better understanding on the part of the students, but it has also proved of great interest to citizens and parties of Iowa City school children. With the growth of manufactures in Iowa, power development is attracting increasing attention in spite of the state's small water-power resources.

Plans Under Way for Preparation of Model Traffic Ordinance

Because the uniform vehicle code approved by the Second Conference on Street and Highway Safety, after it had been prepared by committees appointed at the first Conference applies particularly to states as a whole, a model city ordinance is now being prepared that will apply particularly to cities.

A special committee formulating the model ordinance known as the Committee on Municipal Traffic Ordinances and Regulations met recently in Detroit and appointed six sub-committees to prepare different phases of the ordinance. The membership of the committee was formed by invitations from Secretary of Commerce Hoover. Sub-committees were appointed on vehicle movement and regulations; pedestrian facilities and regulations, street traffic signs, signals and markings; parking, garages, terminals, loading facilities and street obstructions; public motor vehicles, railways, street cars and emergency vehicles; and traffic organization and enforcement. The office of Col. A. B. Barber, manager transportation and communication, Department of Commerce, and director of the national conference on street and highway safety, now is collecting ordinances in 100 cities, which will be allocated to the several sub-committees, according to subject, for study. It is expected that the sub-committees will complete their work about the first of next year.

Large Car Shops for N. Y. Subways

Contracts are now being carried out for grading the site and building a bulkhead and car float bridge on the ground where a $3,000,000 car shop and maintenance plant for New York City's new subway system will soon be built. The plant will be on a tract of 49 acres between 207th and 215th Streets, from 10th Avenue to the Harlem River, Borough of Manhattan. Contracts will soon be advertised for the main group of buildings to be constructed of brick 35 feet high; they will consist of machine shops, electrical repair shops, car shops, track shops, wheel and axel shops, wood mill, carpenter shop, blacksmith shop, paint shop and inspection shed. In addition to these there are 10 other structures segregated from the main plant. The total area of the buildings included in the contract under consideration is 459,000 sq.ft. or 21 per cent of the total acreage of the site. There will be storage capacity in the yards for 500 cars.

Compact Ratification Expected

Secretary Work, according to press dispatches from Culver, S. D., dated Aug. 9, has reported to President Coolidge that early ratification by the seven states concerned of the Colorado River Compact is probable before the next session of Congress.

Hearings Concluded on Albany Water Supply Increase

Hearings were concluded on July 25 before the New York State Water Power & Control Commission on the application of the city of Albany for permission to make the initial development in its Hannacrois-Basic Creek water supply project. It is expected that a decision will be reached within the 90 days allowed by statute.

The project is substantially the same as that recommended by Robert E. Horton, consulting engineer, Albany, N. Y., (*Engineering News-Record*, Sept. 23, 1926, p. 520) with the addition of a 30-m.g.d. filtration and aeration plant. The supply would be from a 1,100-m.g. storage reservoir on Basic Creek and a 11,600-m.g. storage reservoir on Hannacrois Creek, connected by a mile of 72-in. conduit. Water from the larger reservoir would be delivered to the filters through a 48-in. steel conduit of 44-m.g.d. capacity, 19 mi. long. A 48-in. pipe would lead from a new filtered water reservoir in North Albany to the distribution system. The short conduit between the two reservoirs would have a capacity of 200 m.g.d. to provide for the extension mentioned further on. This is the project covered in the report by Fuller & McClintock, consulting engineers, New York City, dated May 2, 1927. The catchment area is 49.5 sq.mi. and the estimated safe gross yield 31.5 m.g.d., of which 29 m.g.d., would be available for Albany, reserving the balance for Ravena, whose present supply would be cut off by the new development.

An early start is expected on construction of the first stage of the project, estimated by Fuller & McClintock to cost $9,363,000, including $1,500,000 for improvements to the distribution system. The second stage contemplates the ultimate use of water from the Catskill Creek and Ten Mile Creeks, the water bringing the total available supply to 65 m.g.d., and the total cost to $21,000,000. The water from this additional source has been reserved for the city of New York under a state permit granted some years ago, but never utilized.

Personal Notes

GILBERT A. YOUNGBERG and the GEORGE B. HILLS Co. announce affiliation under the firm name of Hills, Youngberg & Luce for the practice of civil engineering, with offices in Jacksonville, Fla., in the Liggett Building. Each will continue present practice under the old name but the organization will be available under the new name for consultation.

SCOTLAND G. HIGHLAND has been reinstated as secretary and manager of the water board of Clarksburg, W. Va., which position he had held for 21 years when the board appointed a local coal dealer in his place last May. The reinstatement appears to have been due to a public demand, based on Mr. Highland's long record. At the same time the board reinstated MARCH L. PRITCHARD, construction engineer, who until recently had been with the board since 1917.

GEORGE M. SHEPARD resigned as chief engineer of the Department of Public Works, St. Paul, Minn., effective Aug. 1, to become chief engineer for the Northern States Contracting Co., of St. Paul. He has been chief engineer since 1922. His successor has not yet been appointed.

BLAKE VANLEER, associate professor of mechanical engineering at the University of California, specializing in hydraulics, has been selected as recipient of the John R. Freeman traveling scholarship and will leave September 1 for a year in Europe to be spent visiting and studying hydraulic and hydroelectric works of all kinds.

H. S. SCHICK, of Huntington, W. Va., has resigned his position of associate engineer, U. S. Engineer Department, to become resident engineer on the construction of the Stanton bridge over the Ohio River at Steubenville, Ohio, for the Dravo Contracting Co. Mr. Schick is a graduate of the University of Cincinnati and was formerly with the Guyaquil and Quito R.R. Co. of Ecuador, S. A., and later with the Bureau of Public Works and the city of Manila, Philippine Islands.

V. W. RUSSELL who has been office engineer in the field division of the U. S. Bureau of Reclamation has been promoted to division engineer of the reclamation service, with headquarters at South Cle Elum, Wash.

MAJOR JOHN W. N. SCHULZ, Corps of Engineers, U.S.A., who has been district engineer at San Francisco for almost three years, has been transferred to Camp Lewis for duty with the Sixth Engineers, beginning Sept. 1. Major Schulz is to be succeeded at San Francisco by Col. Thomas H. Jackson, who will serve both as district engineer of the San Francisco District and also as division engineer of the Pacific Division which includes California, Arizona, New Mexico, part of Nevada and Hawaii.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

AMERICAN WELDING SOCIETY, New York City; Fall Meeting, Detroit, Mich., Sept. 19-23, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

Obituary

GEORGE A. PALMGREN, a civil engineer of Summit, N. J., died July 29 as a result of heat prostration. Mr. Palmgren was 40 years of age.

CHARLES MALLISON, of Pottstown, Pa., chief engineer of construction for the McClintic-Marshall Co. on the building of a bridge at Bath, Me., over the Kennebec River, was fatally injured Aug. 1 while inspecting the towers by which the draw-span was to be lifted into place the next day. Mr. Mallison and George T. Bullard, resident engineer for the contractor, had climbed one of the towers and were descending, Mr. Bullard in the lead, when Mr. Mallison slipped on the wet steel and fell 50 ft. to the water. He swam toward a boat, which rescued him, but died later in a hospital. Mr. Mallison had been with the company since his graduation from Cornell in 1898.

HOMER C. CAMPBELL, civil engineer and retired contractor, Portland, Ore., died July 27, at his home in Portland, Ore., aged 75 years. Mr. Campbell was engineer for the Pacific Bridge Co. He designed and the company built many bridges in Portland and the Northwest.

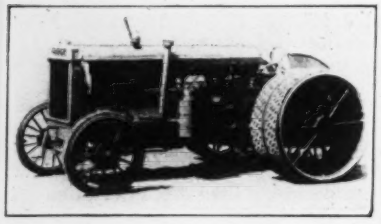
BENJAMIN F. BUSH, St. Louis, Mo., former president and chairman of the Board of the Missouri Pacific R.R., died July 29, in a St. Louis hospital, at the age of 67 years. Mr. Bush, born in Wellsboro, Pa., and a graduate of a Pennsylvania State Normal School, entered railroad work in Wisconsin as a rodman for the Northern Pacific Ry. Within five years he was made division engineer for the Northern Pacific R.R. in Idaho and Oregon. For seven years he was chief engineer and general superintendent of the Oregon Improvement Co., and later general manager of the Northwestern Improvement Co. in Washington. He joined the Gould lines in 1903 as fuel agent for the Missouri Pacific at St. Louis. In 1907 he was made president of the Western Maryland Ry. Mr. Bush was elected president of the Missouri Pacific Ry. in 1911 and until 1923, when he was made chairman of the Board of Directors, he devoted himself to improving the services and policies of the road. During this period he was for a short time president of the Denver & Rio Grande Western and the Western Pacific, but relinquished those presidencies to give more time to the Missouri Pacific. During the World War he was regional director of the Southwestern Division during the period of federal control.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Heavy Tractor Equipped with Rubber Tires

A new four-cylinder industrial tractor claimed to be the heaviest wheel tractor yet equipped with rubber treads has recently been developed by the Huber Manufacturing Co., Marion, Ohio. It is suitable for freighting, road building, road maintenance and general industrial service where the loads to be handled are beyond the capacity of smaller industrial tractors. It is made in three sizes that deliver 22, 30 and 40 hp. respectively at the draw bar and is



provided with a low speed of 1½ to 2 m.p.h. for heavy work and a high speed of 4½ to 5½ m.p.h. for long distance freighting service. The transmission is inclosed and runs in oil and the tractor is equipped throughout with roller bearings. Power take-off and belt pulley equipment are provided.

The rear tires are 50 in. in diameter with a 10-in. face, to which a 10-in. extension may be added as shown in the illustration. The rubber tread has a thickness of about 3 in. The front wheels are equipped with solid rubber tires 34 in. in diameter with a 5-in. face.

Six-Cylinder Road Builder's Truck for Long Hauls

A new Model 615-A road builder's truck, recently introduced by the Indiana Truck Corp., Marion, Ind., is a 6-cylinder machine, equipped with a two batch body. The 6-cylinder engine is said to give smoother power, eliminate vibration, as well as permit higher speed, and is used principally where longer hauls are required and fewer stops. The machine will be furnished with a 60-72 cu.ft. dump body, for two 7-bag batches,

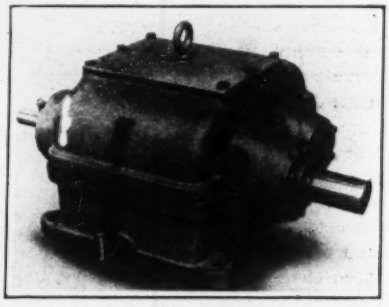
1:2:3, mix; for two 6-bag batches, 1:2:4, mix; or for two 6-bag batches, 1:2:3½ mix. In all cases the cement is carried in sacks on top of the sand and stone.

Other specifications of the new truck are as follows:

Wheelbase 136 in.; speed 34 m.p.h.; turning radius 24 ft.; width of frame 34-in.; and length back of seat 7 ft. 4 in. The length from the seat to the center of rear axle is 4 ft. 9½ in.

New Speed Reducer Mounted In Oil-Tight Housing

A new line of speed reducers is being manufactured by the Stephens-Adamson Manufacturing Co., Aurora, Ill., whose outstanding feature is the fact that all sizes are fitted with spur gears fully en-



closed in an oil-tight housing. Ratios vary up to 2000 to 1 for the standard sizes and the equipment is built for capacities which range from 1 to 300 hp. Advantages claimed for this speed reducer are compactness, proper and lasting alignment, elimination of open gear hazard, assurance of correct lubrication.

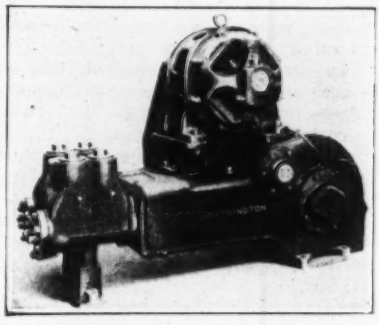
It is also announced that the Stephens-Adamson Co. has provided new and extensive equipment for producing gears of all kinds on a quantity basis. This new gear department will specialize in the production and distribution of gears and speed reducers.

Asphalt Coated Concrete for Pipe and Pavement

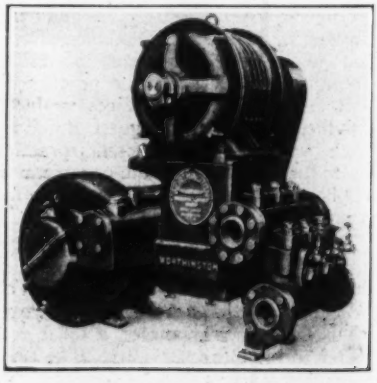
A process for applying asphalt to concrete for waterproofing flat concrete surfaces, for paving and for the lining of concrete pipes, is being introduced into the United States by the Asphalto-Concrete Corp., New York City. The corporation controls the patents in the United States covering the Billé-Ligonnet process, which was originated in France and which it is said has there been used for asphalt lined concrete pipe and for asphalt paving block. The corporation also controls the United States patents covering the Moir-Buchanan centrifugal process for making concrete pipe. In this process the pipe is spun at a much lower speed than is required for proper centrifugation in order not to throw the denser particles to the outside. The required density of the lining is secured by compacting it with a combination knife and trowel held in place inside the revolving form. It is said that the company has a plant in operation in Montreal, Canada, and that another plant is nearing completion at Hicksville, L. I., N. Y. The newly formed organization has for its officers the following: A. T. Lundin, president; George W. Goethals, consulting engineer, for first vice-president; R. W. Mitchell, consulting engineer, for second vice-president; James L. McSweeney, president of the Equitable Securities Corp., Montreal, director; Henry R. Swartley, Jr., president of the National Bank of Great Neck, L. I., and president of the Atlantic Cement Products Co., Inc., for a director.

Duplex and Triplex Power Pumps Are of Self-Oiling Type

Two new inclosed horizontal power pumps of duplex and triplex types, have recently been developed by the Worthington Pump & Machinery Corp., New York City. Both pumps are intended for work where dust and grit are especially active. The mechanisms of both pumps are covered by a cast-iron case.



The duplex pump is made in six sizes, the piston diameters being 2½, 3, 3½, 4, 4½ and 5 in., and the stroke 10 in. in each case. They are designed for from 42.5 to 195 g.p.m. and for pressures of from 350 to 1,400 lb. per sq.in.



The triplex, single-acting pump is made in two sizes, 2¾x5 and 3¼x5. The smaller pump has a displacement of 77½ g.p.m. against a pressure of 500 lb. per sq. in., and the larger a displacement of 108 g.p.m. against a pressure of 360 lb. per sq. in. The gear ratio is 6 to 1, hence the pinion shaft may be direct-connected to a 1,200-r.p.m. motor or engine without additional gearing or belts. On both pumps, the rim of the main gear dipping in the lubricant carries oil to the top of the crankcase from whence it is distributed to all bearings, connecting rods, gearings, and crossheads.

Business Notes

A. ANABLE, for several years connected with the equipment sales department of the Dorr Co., New York City, has been appointed to the position of director of publicity of the Dorr Co.

MILWAUKEE CORRUGATING CO., Milwaukee, Wis., on October 1 will move its Chicago quarters to a new and larger location at the corner of Western Avenue and West 43d St., Chicago. The building is a modern three story and basement structure of reinforced concrete and contains 75,000 sq.ft. of floor area. Most of the space will be devoted to the warehousing of the company's line of metal lath, roofing, metal ceilings, metal tile, metal shingles, etc.

TAR PRODUCTS CORP. announces that it is now affiliated with the American Tar Products Co., Pittsburgh, Pa. It will be operated as heretofore but known as the New England division of the American Tar Products. Co.

GIBB WELDING MACHINE CO., Bay City, Mich., announces that John A. Toleik has accepted the position as chief engineer and has severed his connections with the American Can Co. In his former position Mr. Toleik had charge of all the company's welding developments. His new position will be to enlarge and further the development of the Gibb company's research department.

STEARNS CONVEYOR CO., Cleveland, announces that Lynn B. McKnight, who for the past eight years has been connected with the Dodge Manufacturing Co., Mishawaka, Ind., has been appointed sales manager of the former company which is owned by the Chain Belt Co., Milwaukee.

LINCOLN ELECTRIC CO., Cleveland, announces that its Missouri district office has been moved from St. Louis to Kansas City. Robert Notvest is in charge. A branch office has also been established in Toledo, Ohio, A. H. Homrighaus, formerly in charge of the Missouri district having been transferred to Toledo in charge of the new district.

J. M. ALLEN, consulting engineer, of Chicago, has jointed the organization of Hetherington & Berner, Indianapolis, manufacturers of pumps. This company plans to manufacture a full line of sand and gravel machinery. Mr. Allen will continue his consulting work in Chicago and represent the company in the design and sale of the equipment they manufacture.

FREDERICK M. FISK has become manager of the Pacific Coast office of McIntosh and Seymour Corp., with offices at 815 Sheldon Building, San Francisco.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago: Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago: Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia: Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York: Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS: Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Metal Lath, Roof Trusses and Steel Windows—MACOMBER STEEL CO., Canton, Ohio, has recently issued three new catalogs describing, respectively, its metal lath, its roof trusses and its steel casement windows. The metal lath catalog classifies metal lath by different methods of manufacture and by the uses for which each is adapted. Recommendations are given as to which type to use. The information in the catalog is usable by contractors regardless of the brand of lath used. The roof truss catalog contains safe loading tables for use in designing buildings with curve chord and "A" type steel roof trusses. Structural detail drawings are included. The steel window catalog covers the standardized products of casement windows, horizontally pivoted or industrial windows, door frames and lintels, for all of which typical details and installation methods are given.

Clarifiers and Bar Screens—DORR CO., New York City, recently issued bulletins No. 6171 and 6371 devoted respectively to its traction clarifiers and its self-cleaning bar screens. The traction clarifier for continuous sedimentation is described and illustrated. The operation of the self-cleaning bar screen is explained both by text and photographs.

Hoist Information—NOVO ENGINE CO., Lansing, Mich., has issued a revised copy of the Novo Hoisting Handbook, to which 12 new pages have been added, making it now a 44-p. book. It is devoted exclusively to useful information on hoisting problems, considering such diverse services as material elevating, concrete handling, clamshell and derrick work, steel erection, industrial car hauling, piledriving, dragline work, and logging. Useful information on rope reeving and many construction illustrations are included.

Carbon Monoxide Recorders for Gasoline Engines—BACHARACH INDUSTRIAL INSTRUMENT CO., Pittsburgh, Pa., has issued a bulletin describing its electric CO meter for carburetor adjustment on high speed internal combustion engines. A description of the advantages of the recorder, and its method of operation are given.

Airway Lighting — WESTINGHOUSE LAMP CO., New York City, has devoted bulletin E-107 to "Airport and Airway Lighting." In the 40 pp. the guiding purpose has been to review briefly the progress in aviation lighting and to present discussions with a view toward promoting further research. Present theory and practice are considered and illustrated by photographs and drawings.

Crawler Cranes—LINK-BELT CO., Chicago, in its Bulletin No. B-10, describes its all-purpose machine for shovel, dragline, trench shovel, skimmer and crane work. Illustrations, and capacity and specification tables are included.

Welding and Cutting Equipment—SMITH WELDING EQUIPMENT CORP., Minneapolis, Minn., has published a 48-page catalog for 1927 describing and illustrating its oxyacetylene welding and cutting equipment. A number of complete outfits are described in detail and tables of welding torch specifications are included.

Traffic Control—GENERAL ELECTRIC CO., Schenectady, in its Bulletin GEA-566, describes its "Novalux" traffic signals. In addition to this, the various types of traffic control systems are reviewed. A number of accepted locations for signal installations are diagrammed and explained. The booklet contains 25 pages.

Steel Reinforcement for Buildings—GENERAL FIREPROOFING BUILDING PRODUCTS, Youngstown, Ohio, has issued a 47-p. catalog describing its "self-centering" which is described as a combined form and reinforcement for floors and roofs and its "Trussit," a corrugated expanded metal sheet for re-

inforcement of solid partition and curtain walls. Details of the manner of installation in various types of floors, walls and ceilings are given, while specification tables furnish all necessary information for ordering. Many illustrations of the material in use are shown for both usual and special building operations.

Industrial Track—BETHLEHEM STEEL Co., Bethlehem, Pa., now has available a 158-p. catalog giving all necessary information on its mine and industrial track and accessories. Not only is information given for ordering the product, but data, tables and calculations of practical value to users of light rail equipment are included.

Stacker Equipment—LEWIS-SHEPARD Co., Boston, has issued the 1927 edition of its "Jacklift and Stacker Practice" pamphlet. The special machines illustrated and described constitute a complete assembly of lift trucks and stackers and equipment is included for practically every type of material handling job.

Highway Equipment — RUSSELL GRADER MFG. Co., Minneapolis, Minn., in its catalog No. 27, devotes 48 pages to its road equipment. Although devoted largely to the company's complete line of graders of various types, such other equipment as crushing plants, steel bins, draglines and conveyors are illustrated and described. A comprehensive 2-page table gives comparative specifications for all Russell graders.

Manufacturing by Welding — LINCOLN ELECTRIC Co., Cleveland, Ohio, has published a 36-p. booklet outlining briefly the theory and use of arc welding in production manufacturing. The first part of the book is devoted to the replacing of iron castings by standard rolled steel sections joined by arc welding. Another section of the book is devoted to arc welding in the tool room. Consideration is given to the welding of heavy duty machinery such as power shovels, and locomotive crane booms. Many illustrations are included to make the booklet more complete and of greater value.

Power Shovels and Cranes—SPEEDER MACHINERY CORP., Cedar Rapids, Iowa, has recently made available a 32-p. catalog describing its shovels, cranes, skimmers and draglines, using either gas or electric power. The mechanical features of each machine are separately illustrated and described, and construction photographs and operating and specification tables give all necessary information concerning the equipment.

Apron Conveyors — JEFFREY MFG. Co., Columbus, Ohio, in its catalog No. 435, describes its standard apron conveyors in both wood and steel types. Illustrations, diagrams, text and specification tables are given and the 66-p. catalog is completed by some half dozen pages of dimension drawings and tables.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Do You Want Unit Costs on Buildings, Etc.

WITH the encouragement of many of its readers *Engineering News-Record* has undertaken to collect and publish unit cost data on buildings of all types, power plants, grain elevators, gas holders, wharves, and, in fact, all kinds of structures in addition to those already treated weekly in the Unit Prices section. It is readily granted that the task is no light one. Without hearty co-operation it is hopeless.

Unit prices on public work are available to anyone who wants them. The pick of them are published in *News-Record*. With private work and public utilities improvements, however, an entirely different, and a difficult, situation is encountered. Unit costs are concealed and guarded with the same zeal as were "trade secrets" a few years ago.

A letter requesting cooperation, addressed to 700 engineers and engineering firms who design industrial plants, has elicited much commendation but few cost data, as yet. Quoting from one excellent letter:

"Unfortunately, most of the power companies and engineering corporations seem to take the position that cost data should be kept more or less secret, and most of the data that I have in my possession has been given to me with the understanding that I would consider it confidential."

This used to be the attitude of manufacturers of materials and supplies. Ten years ago, when *News-Record* was enlarging and standardizing its Market-Prices section, considerable reluctance was met to giving out prices for publication. This attitude has disappeared entirely.

Eventually, costs of all kinds that would benefit the public to know will be freely exchanged and published. In the present case the public to whom adequate cost data should be at hand consists largely of engineers and contractors. Many members of this public have their own private stock of costs, gathered on the jobs with which they have been connected. Many letters have been received expressing willingness to cooperate in building a pool of unit costs that will turn out to be a service for all.

Everyone who is interested in obtaining reliable construction costs is urgently invited to step forward and contribute a portion of his own collection. In addition, suggestions, comments and criticisms will receive careful attention.

Construction News Editor,
36th St. at Tenth Ave.,
New York, N. Y.

Unit Costs on Power Plant at Fairfax, Okla.

THE unit costs given herewith for the Fairfax Electric Light, Heat and Power Plant have been passed on by the Corporation Commission of Oklahoma and approved and accepted by the Federal Court as fair and just for that territory at the time of construction in March, 1925.

Because of limited space, details of development of cost of forms, concrete, and cement mortar have been omitted in the table showing foundation costs. For the same reason only summaries are given for the cost of excavating, concrete foundations, reinforced concrete roof, brick masonry and carpentry.

The unit cost of dimension lumber for forms was 5½c. per bd.ft. and the total cost for the form for each of the engines installed was: 37½ hp. engine, $31.24; 75 hp. engine $33.77; 200 hp. engine, $123.59; 300 hp. engine, $144.71. The total labor cost for each form including a carpenter at $1 and helper at 50c. per hr. was $12, $15, $82.50, and $97.50 respectively.

The unit cost of cement was $3.40 bbl., sand $2.25 cu.yd., and stone $4 cu.yd. Materials plus labor, insurance, and wastage made the total cost of concrete $12.99 per cu.yd. and cement mortar $17 cu.yd. It was estimated that one foreman at $1 per hr. and six laborers at 50c. each per hr. mixed and put in place one cu.yd. of concrete or cement mortar per hr.

In estimating excavation costs, the tool expense was considered 5 per cent of the total for scraper and 3 per cent for hand excavation. Labor rates were $1 per hr. for man, team and scraper and 40c. for extra man with scraper. Hand laborers were paid 50c. per hr. A comparison of the total labor cost per 100 cu.yd. excavated shows a ratio of three to five in favor of the scraper.

BUILDING I

Painting and Decorating—10,000 sq.ft., three coat work on wood:

Material, 50 gal. of paint@$3.50	$175.00
Painters, 200 hrs.@$1.25	250.00
Superintendence 10 per cent, insurance 6 per cent	68.00
Cost for 10,000 sq.ft.	$493.00

Concrete Foundations—Cost by hand and mixer, per cu.yd. for wall 1 ft. thick:

	Hand	Mixer
Mixing	$2.52	$1.36
Lumber forms (used twice)	2.81	2.81
Labor for forms	4.59	4.59
Concrete	8.33	8.33
Total	$18.25	$17.09

Reinforced Concrete Roof—4-in., cost per sq.ft.:

Labor placing Hy-Rib	$0.025
Cost of Hy-Rib	.040
Framing labor	.070
Framing material	.145
Cost of concrete	.116
Tar and gravel roof covering	.075
	$0.465

(Continued on p. 248)

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
August 11, 1927	$33,602,000	$52,530,000	$86,132,000
August 4, 1927	36,718,000	44,528,000	81,246,000
August 12, 1926	22,002,000	38,919,000	60,921,000
Jan. 1 to date			
1927	727,040,000	1,114,721,000	1,841,761,000
1926	689,408,000	1,101,628,000	1,791,036,000

E.N.-R. Index Numbers On August 1, 1927

COST	VOLUME
205.50	252

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes per 100 lb	$3.34	$3.80	$4.00	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, per 100 lb.	5.00	3.80	4.75	3.50	3.75	4.64	5.00	5.25	5.50
Reinforcing bars, per 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	54%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	—44.60	40.00	54.00	—42.20	46.50	56.50	—43.00	55.00	4—1.00
Concreting Material									
Cement, without bags, per bbl.	2.35†	2.40	2.05	2.05	2.22	2.85	2.51	2.65	2.22
Gravel, ¾ in. per cu.yd.	1.75	2.20*	2.38	2.00	1.65	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.40*	2.00	2.00	1.25	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in. per cu.yd.	1.85	2.50*	2.83	2.00	1.75	2.50	1.70	3.00	2.00*
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	62.00†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	—39.00	39.25	34.25	27.00	+24.50	55.00
Lime, finishing, hydrated, ton	18.20	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00‡	1.35	1.82	1.50	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	—17.00†	12.50	13.60	12.00	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724	.103	.....	.072	.085	.....	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724	.103	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.84	91½	1.10	—.83½	.93	— 1.02	.92	.98	1.03
Common Labor									
Common labor, union, per hour.	.90⅞	.30	.....	.90	.....	.....	.60	.70	.....
Common labor, non-union, hour.	.....	.25	30@.50	.82½	.45@.60	31½@.50	.50	.62½	.30@.35

*Ton. †Delivered. ‡280-lb. net. +Advance. —Decline.

Explanation of Prices

Structural Shapes: Beams, 3 to 15-in.; channels, 3 to 15-in.; angles, 3 to 16-in., ¼-in. thick; tees, 3-in. and larger. Prices are per 100-lb., at warehouse, in less-than-carload lots.

Structural Rivets: Round head, per 100-lb., in full keg lots, at warehouse.

Reinforcing Bars: Rolled from billets, ¾-in. and larger, per 100-lb., at warehouse, in less-than-carload lots.

Wrought-Steel Pipe: Black, 2½ to 6-in., lap welded, prevailing discounts from standard list, at warehouse, in less-than-carload lots.

Cast-Iron Pipe: Class B and heavier, size 6-in. and over, per net ton, in carload lots, f.o.b. city.

Portland Cement: Per bbl. of four bags, without charge for containers, in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Gravel: Size ¾-in., per cu.yd., weighing 1½ tons, in carload lots, f.o.b. city.

Sand: Per cu.yd., weighing 1¼ tons, in carload or cargo lots, f.o.b. city.

Crushed Stone: Size ¾-in., per cu.yd., weighing 1½ tons, in carload lots, f.o.b. city.

Pine and Fir Lumber: Prices are for rough timbers, size 3 x 12-in. to 12 x 12-in., in 20 ft. lengths and under, per M. ft. b.m., in carload lots to contractors, f.o.b. city. Long-leaf yellow pine is quoted on in certain of the cities and Douglas fir in the rest of those covered by the table, according to nearness to source of supply.

Lime: Hydrated, finishing lime, per ton, at warehouse, in carload lots.

Common lump lime, at warehouse, in carload lots, per small bbl. of 180-lb., net, or large, 280-lb., net, as noted in the table.

Common Brick: Price per M. in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Hollow Tile: Building (load bearing) or partition tile, 4 x 12 x 12-in., per block, in carload lots, f.o.b. city, or delivered to job, as noted in the table.

Linseed Oil: Prices are for raw oil in 5-bbl. lots, per 7½-lb. gal., delivered to job.

Common or Unskilled Labor: Rates are per hr., for pick-and-shovel or clean-up men in construction operations, union and non-union.

Price changes noted in the table, advances (+) and declines (—) are comparisons with July 28 levels.

THIS limited price list is published Weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Aug. 4, the next on Sept. 1.

(*Concluded from p. 246*)

Excavating—Scraper and hand, cost per cu.yd.:

	Scraper	Hand
Sand or loamy soil	$0.33	$0.64
Ordinary soil	.605	.99
Heavy soil and clay	.745	1.415
Average	$0.56	$1.015

Common Brick—Cost per M., in place:

Cement mortar, 15 cu.ft.@$0.62	$9.30
Labor (including 10 per cent superintendence, 6 per cent insurance)	15.46
1,000 common brick	15.00
Total cost 1,000 bricks in place	$39.76

BUILDING II

Brick Masonry—Common brick, cost per M, in place:

15 cu.ft. mortar	$3.75
Labor mixing	.56
Handling and laying brick	13.63
Cost of brick per M	14.00
	$31.94

Face Brick—Cost per M, in place:

12 cu.ft. mortar	$3.00
Labor mixing	.44
Handling and laying brick	22.13
Cost of brick per M	24.00
	$49.75

Carpentry—Average costs per M. ft. b.m.:

	Labor	Material	Total
Ordinary framing	$25.72	$42.50	$68.22
First-class framing	31.24	42.50	73.74
Sheathing	16.87	42.50	59.37
Siding	24.97	75.00	99.97
Pine flooring	23.51	75.00	98.51

Painting and Varnishing—Cost per 100 squares; paint, $2.10 per gal.; cold water paint, $0.07 per lb.; labor, $1.25 per hr.; liability insurance, 5.9 per cent; and superintendence, 10 per cent, included in total:

	Gal. Paint	Hrs. Labor	Total Cost
Priming, cost on wood	25	100	$202.63
Two coat work on wood	37	160	317.27
Three coat work on wood	50	200	405.25
One coat on rough brick or plaster	40	96	231.48
Two coats on rough brick or plaster	63	136	342.56
Three coats on rough brick or plaster	80	200	474.55
Cold water paint by hand	150 lb.	56	92.68
Cold water paint, machine sprayed	150 lb.	24	46.32

Carpentry—(Building I) Labor costs per M. ft. b.m. of lumber; rate for carpenters $1.25 per hr.; laborers $0.50 per hr.; superintendence 10 per cent; liability insurance 6 per cent, included in total:

	Hours		
	Carpenters	Laborers	Total
Dimension lumber (100 ft.) in frame	20	10	$34.80
Framing and placing wood stud walls	26	13	45.24
Framing and placing wood floor joists	16	8	27.84
Framing for construction of roof	40	20	69.60
Applying ship lap to roof	16	8	27.84
Asbestos shingles per 100 sq.ft. (including material)	4	2	22.12
Handling and placing drop siding	24	12	41.76
Installing window and door trim	32	16	55.68

Foundation Costs—

	Unit	Unit Cost	37½ Hp. Engine	75 Hp. Engine	200 Hp. Engine	300 Hp. Engine
			Number of Units			
Excavation	Cu.yd.	$ 1.00	26	30	82.5	112.5
Concrete	Cu.yd.	12.99	16½	24	77	108
Floating up surface before unit set	Sq.ft., 1-in. thick	.0525	96	112	240	240
			Value of Forms, Etc.			
Forms			$45.11	$51.41	$215.57	$253.65
Engineer and helper			24.00	24.00	28.00	28.00
Total			$314.49	$423.05	$1,338.90	$1,809.67

Prices of Chemicals Related To Construction

Following Are For Unbroken Lots, Spot, F.O.B. New York Market in Large Quantities

CHEMICALS of particular interest in the construction industry may be grouped as follows: (1) Water purification and sewage treatment; (2) paint materials; (3) naval stores; (4) lubricating oils; and (5) road oils.

Prices tabulated are current and represent those applying on orders for immediate delivery in the local market. Quotations cover fairly large sized shipments or round lots, in original containers.

According to *Chemical and Metallurgical Engineering*, few changes in prices of chemicals occurred during the last month, although prevailing levels are slightly below those of a year ago. Price trend in oils, as indicated by the *Chem. & Met.* Weighted Index Number, continues downward.

Water and Sewage Treatment

Alum: (ammonium) burnt, U. S. P.	
in barrels, per lb	$0.15
ground, in barrels, per 100 lb	3.60 @3.65
Aluminum hydrate: iron free, in bags, per 100 lb	2.00@2.05
Aluminum sulphate: iron free, in bags, per 100 lb	2.00@2.10
Copper sulphate: in barrels, per 100 lb	4.90@5.00
Ferrous sulphate: in barrels, per lb	04½@ .05
Ortho dichlorbenzene, in drums, per lb	.08@ .10
Bleaching powder: in drums, per 100 lb	2.00 @ 2.40*
Blue vitriol: 99%, crystals, carload lots, in barrels, per 100 lb	5.00 @ 5.10
Brimstone: crude, carload lots, bulk, per ton	18.00 @ 19.00*
Calcium chloride: 73@75%, flake	
in bags, per 100 lb	2.04 @ 2.19
carload lots, in drums, per ton	26.00*
Calcium hydrate: in bags, per ton	12.00 @12.50*
Chlorine: liquid, in cylinders, per lb	.05½@ .09*
Lime: (chemical) lump	
in barrels, per bbl	1.80 @ 2.80*
in bulk, per ton	8.50*
Magnesite: calcined, in barrels, per ton	50.00 @ 60.00
Caustic potash: 88@92%, imported, in casks, per lb	.07½@ .08
Soda ash: dense, 58%	
carload lots, in bags, per 100 lb	1.42½@ 1.45
contracts, carload lots, in bags, per 100 lb	1.37½*
Caustic soda: 60% contracts, in drums, per 100 lb	2.60*
Sodium silicate: 40 deg., in drums, per 100 lb	.75 @ .80*
Sulphuric acid: 60 deg., less than car load lots, in drums, per 100 lb	1.12½

Paint Materials

Benzene: (benzol) 90%, in drums, per gal	$0.28*
Coaltar: in barrels, per bbl	9.00 @ 9.50
Naphtha solvent: water-white, in drums, per gal	.40*
Vegetable Oils	
Linseed, raw, 5 bbl. lots, per 7½ lb. gal	$0.84
Chinawood, in barrels, per lb	16¾@ .17
Pigments	
White lead, dry or in oil, per 100 lb. keg	$13.75
Red Lead, dry, per 100 lb. keg	13.75
Red Lead, in oil, per 100 lb. keg	15.25
Zinc Oxide, American process, lead free, carload lots, in bags, per lb	.06½
Lithopone, carload lots, in bags, per lb	.05¾
Barytes, floated, in barrels, carload lots, per ton	23.00*
Shellac, T. N., in bags, per lb	$0.54 @ $0.55

Naval Stores

Turpentine, gum, ex yard, in barrels, per gal	$0.60½@$0.61½
Rosin, "B" grade, per 280 lb. bbl	10.75
Pitch, per bbl	7.50 @ 8.50
Tar, kiln burned, per bbl	12.50 @ 13.50

Lubricating Oil

Black, reduced, 25@30, cold test, in barrels, per gal	$0.13¼@$0.13½
Paraffin, pale, 903 grav., 25.4 B, in barrels, per gal.	.24 @ .25
Pennsylvania, bright filtered, 600E, in barrels, per gal	.28 @ .28½
Spindle, No. 200, pale, in barrels, per gal	.33 @ .34

Road Oils

Following are the prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

New York, 45% asphalt (at terminal)	$0.0725@$0.075
New York, 65% asphalt (at terminal)	.0675@ .0725
New York, binder (at terminal)	.07 @ .075
New York, flux (at terminal)	.07 @ .075
New York, liquid asphalt (at terminal)	.07 @ .075
St. Louis, 40@50% asphalt	.052
St. Louis, 50@60% asphalt	.0554
Birmingham, 55% asphalt	.0475
Dallas, 45% asphalt	.0495
Dallas, 50% asphalt	.0455
Dallas, binder	.061
San Francisco, binder, per ton	12.00†

*F.o.b. Works. †F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.